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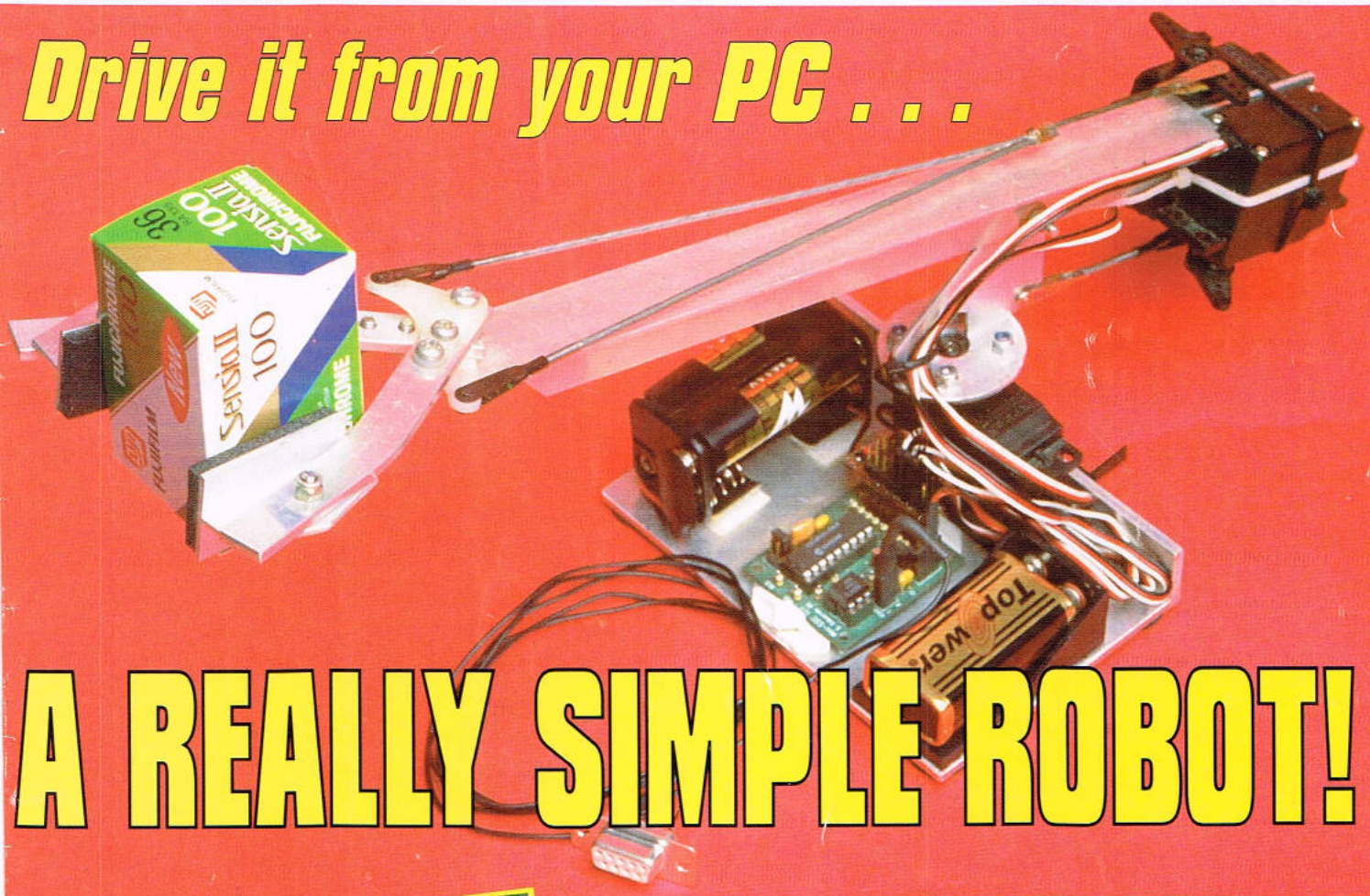

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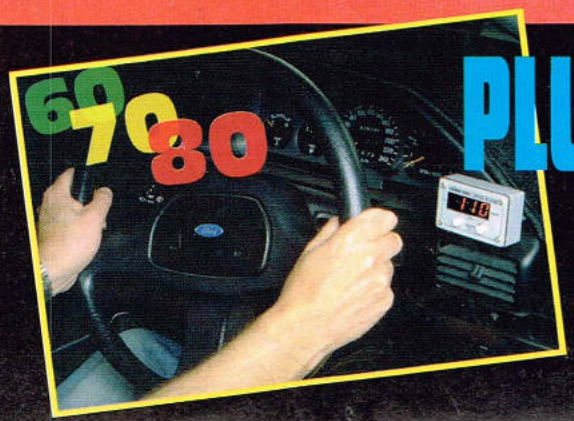

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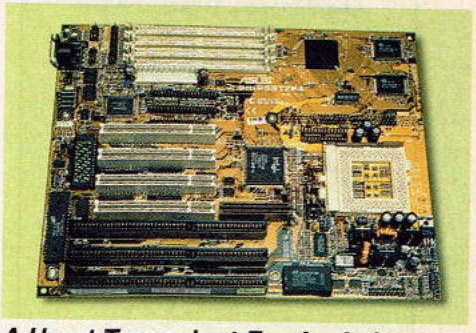

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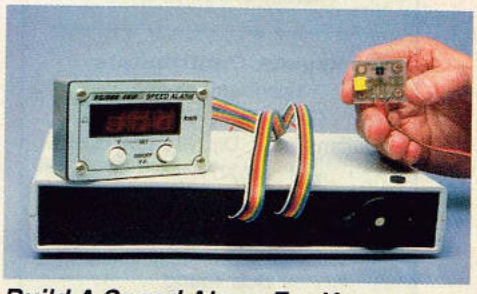

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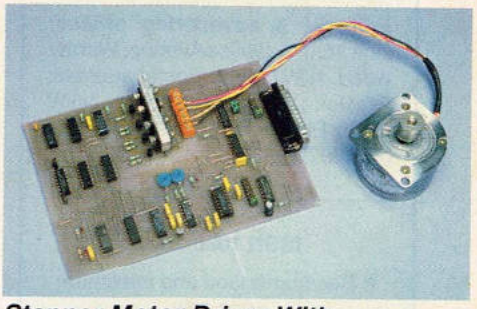

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PUBLISHER'S LETTER

Compact discs are simply too expensive

Just recently the Federal Cabinet has been deliberating on the cost of CDs and trying to decide whether to open the industry to more competition from overseas suppliers. Predictably, the local recording industry has trotted out the usual jaded and faded "rock stars" to plead their special case.

Well, they can plead all they want and the Government can decide to do something or nothing but whatever happens, the sales of CDs will continue to fall while they stay at around $30 or more. Record buyers instinctively know that $30 for a piece of plastic is just too much. Every time they see a computer magazine with a CD-ROM stuck to the front they get the same subliminal message rammed home: CDs and CD-ROMs are dirt cheap to produce.

That message is reinforced when you go to weekend street stalls and see literally hundreds or thousands of CDs being knocked down at far less than $30. And of course, there are any number of Australian musicians who have decided to have their own CDs produced and they happily sell them for less then $30 and they do very nicely thank you very much. There are also a number of classical labels such as Naxos which retail for $9.95 and by and large, they are very good buying.

All of the above is bad enough for the record marketing companies with their King Canute stance but there are several other factors eating away at the sales of full priced CDs. First, most people don't much like the current crop of so-called "rock stars" and neither do the radio stations. More and more they play the music of the 60s, 70s and 80s. That should tell the record companies something.

Second, sales of recordable CDs are booming. You can now buy them for close to $5 each in quantities of 10. You can bet your life that most of these are not being used just to copy data and software; they're being used for pirate copies of CDs.

Third, many people are buying CDs overseas, either via the Internet or via overseas travel. You can save a bundle and the choice is much wider too.

So no matter what the record companies do, while ever their full priced CDs sell for $30, they are going to be white-anted. The first company to reduce their prices to around $20 will make a killing.

Leo Simpson

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A heart transplant for an aging computer

Should you buy a new computer or upgrade an existing one? Often it depends on how much money you have and whether or not you're prepared to delve into your machine.

By ROSS TESTER

I WANTED – no needed – a new computer. Since purchasing my last computer just on two years ago, software had become so complex, so demanding that my current machine simply wasn't up to it any more.

I guess I'm luckier than the average computer owner. All told I have three computers at home, not because I'm greedy but more because until a couple of years ago I kept expanding the system as a new model came out. So I have managed to assemble a system which would do a small office reasonably proud. Then again, that's exactly what my home system is for – a small office.

And while I also have a reasonable amount of hard disc storage (well, with two or more drives in each machine you'd expect that), the one thing I don't have is performance. I have one computer with a fairly slow 100MHz 586 processor but the majority of my work was still being done on an old faithful 486 machine.

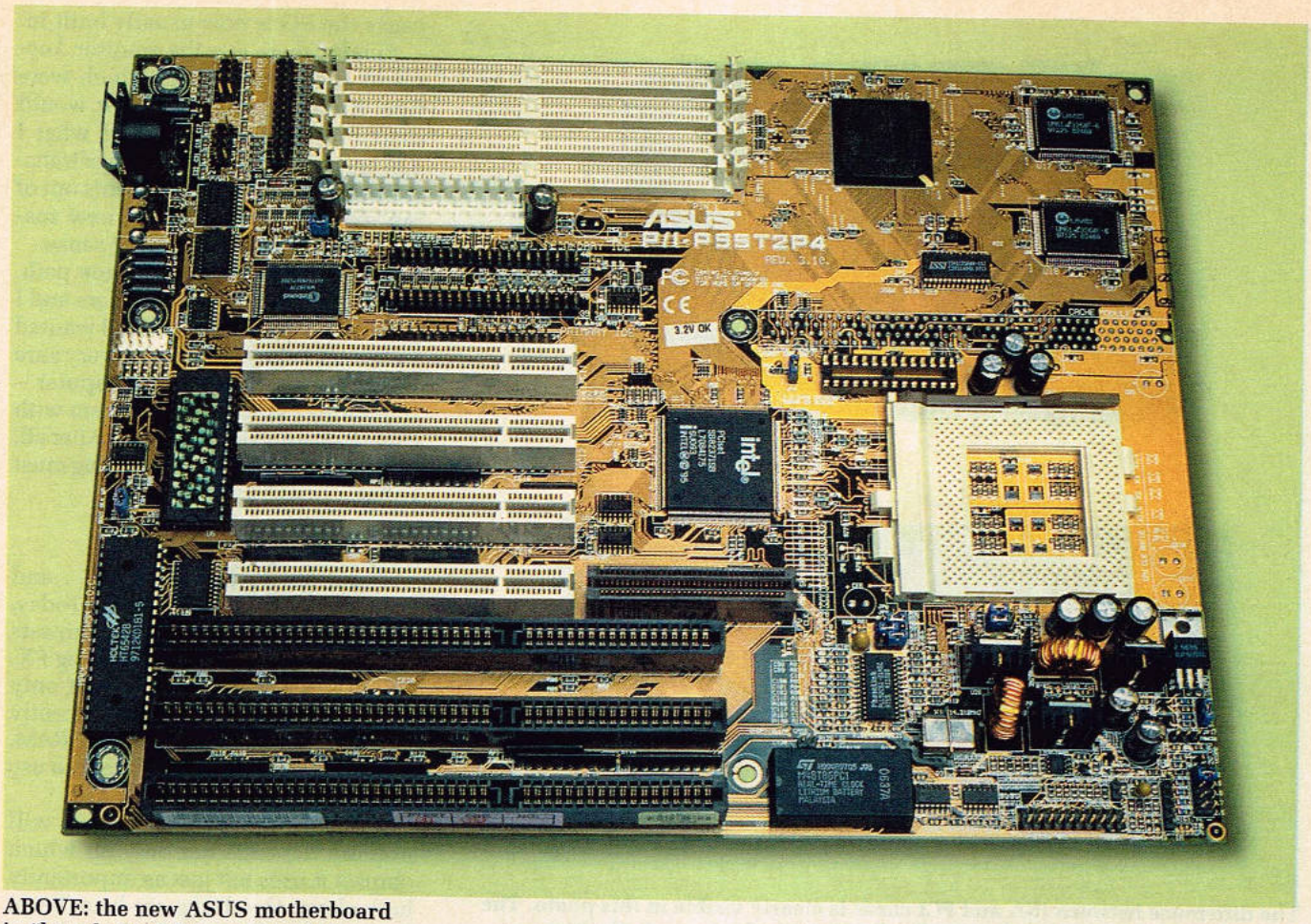
Until fairly recently that didn't matter too much because most of the crunching power I needed was done elsewhere. However, I had to prepare a colour brochure recently and sitting watching that infernal hourglass on the screen convinced me that the time had come! After all, Mr Gates' hourglass was costing me money! But which way to go?

The basis specs

I had already decided on the type of computer I wanted. The basic specs were:

(1) a proven motherboard with the fastest processor I could afford;
(2) the best graphics card I could afford;
(3) the most memory I could afford (absolute minimum 32Mb);
(4) a very fast CD-ROM drive and a large hard disc (or two or three).

With the price of computers almost in free fall over the past year or so,

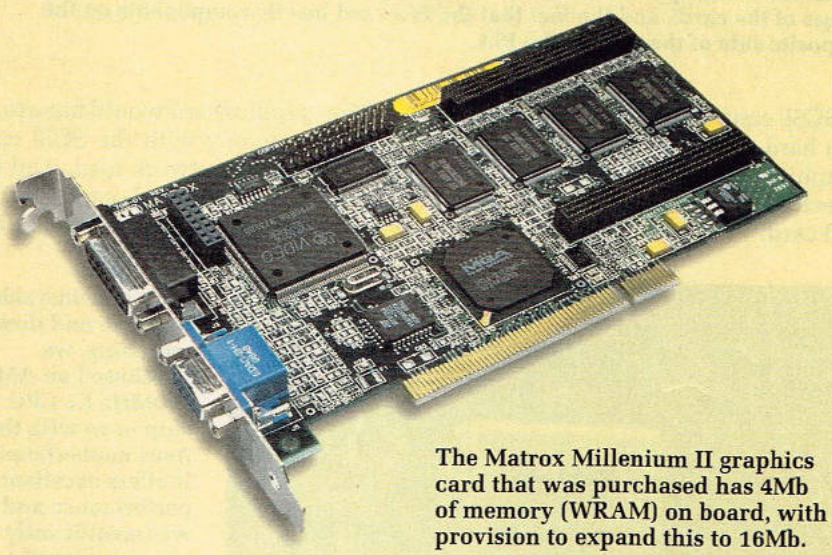


ABOVE: the new ASUS motherboard in "bare bones" form. At top left are the four sockets for 72 pin DRAM, below that the expansion slots – white PCI and black ISA. The large white socket at bottom right is the "ZIF" socket for the CPU. The board will take anything from a 33MHz 486 to a 200MHz Pentium (or equivalent).

was it really a proposition to do what I've done every time before – upgrade the existing computer? Or would it be better to simply lash out and buy a brand new all-singing, all-dancing computer. After all, the sort of machine I wanted was being regularly advertised for about $2500 or less.

"Oh no," she said (she being the she who must be obeyed). "Not another computer. You already have three and you can only use one at a time."

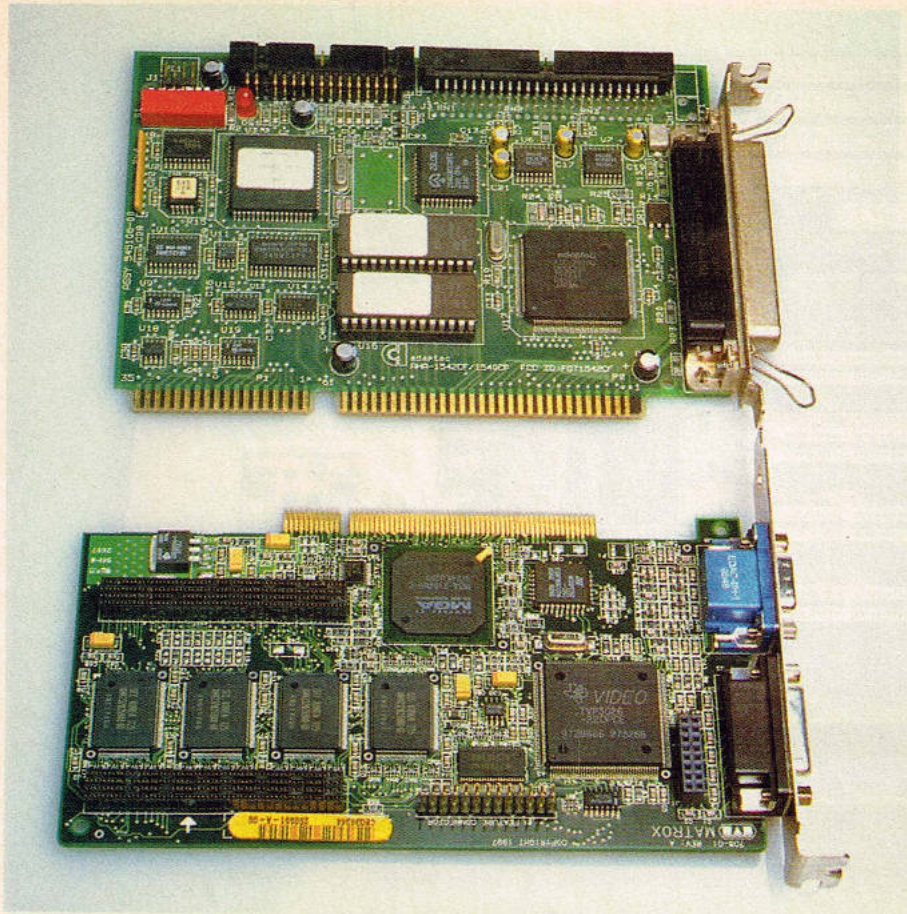
Having seen all the advertisements for what amount to some very good machines, I'm still not sure she was right. But I was able to make a convincing argument for upgrading one of the existing machines. Ours is no different from many mum & dad businesses, "mum" is not only the one who must be obeyed . . . she also keeps a pretty tight reign on the cheque book!



The Matrox Millenium II graphics card that was purchased has 4Mb of memory (WRAM) on board, with provision to expand this to 16Mb.

Looking at it logically (how else do you look at a computer), I already had most of what I needed. First, the old 486 had a perfectly good tower case, complete with power supply, a floppy drive and three hard disc drives with over 6Gb capacity. It also had a magneto-optical drive and not one CD-ROM drive but five (one is a high-speed drive, while the other four are integrated into a CD-ROM jukebox).

As for the internal cards, there was



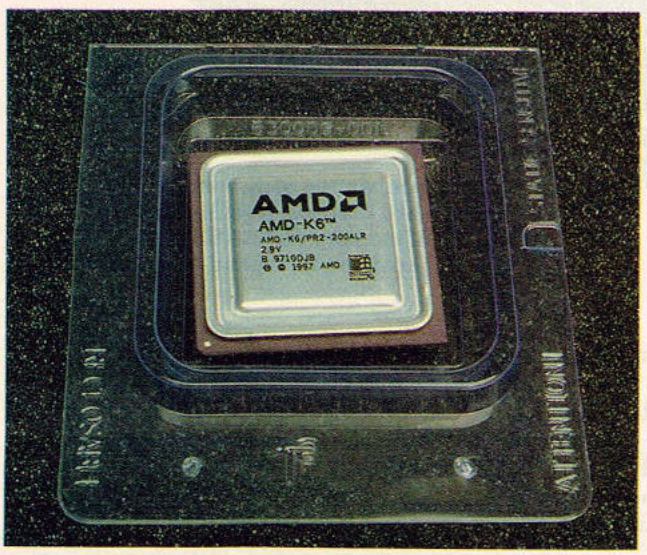
The difference between ISA and PCI cards is clearly visible in this photo. The top card is an Adaptec SCSI controller (ISA) while the lower is the Matrox Millenium II graphics card. Note the difference in the contacts along the bottom edges of the cards and the fact that the PCI card has its components on the opposite side of the card to the ISA.

a SCSI controller (it handled one of the hard discs and the M-O drive), a graphics card which was good but not spectacular, a network card and an I/O card.

The graphics card would have to go but I was happy with the SCSI controller and the network card. And if I bought a new motherboard, the I/O card would no longer be needed because the I/O is now usually built in.

Finally, there was the monitor, keyboard and mouse, all of which were fine. Buying a new computer would therefore duplicate much of what I had and leave me with the job of transferring some of the components out of my existing system to the new machine. It didn't make a lot of sense.

So I went down the upgrade path. In the end, I saved a few dollars and I got exactly the configuration I wanted – after all, I chose it! I'm also very sure about the quality of the computer – something that can be a problem with some bargain-priced systems. After all, if they are that cheap, something must suffer.



After considerable research and then searching, we purchased an AMD 200MHz K6 CPU chip to go with the Asus motherboard. It offers excellent performance and was significantly cheaper than the Pentium equivalent.

The motherboard

There are motherboards . . . and then there are motherboards. Today, most use one of the Triton chipsets and there are several of these; eg FX, VX, HX, TX and LX. Note that only some of these support the recently introduced high-performance SDRAM, so choose carefully if you want to use this type of memory.

Just how well a motherboard will perform depends not only on which chipset it uses but just as importantly how clever the designers have been. Some take shortcuts which might increase performance in one direction but degrade it in another.

I remember only too well a motherboard I bought a few years ago which worked perfectly well with good old DOS. Then Windows came along (actually Windows 3) and it simply refused to work. I took it back to the supplier and he swapped it, no problem at all. "We've had a lot of these motherboards come back recently," he said. The new motherboard was based on the same chipset but from a different manufacturer. It ran Windows without a hitch.

After perusing various catalogs and advertisements, I finally settled on an "ASUS" brand motherboard costing around $300. Although it uses the HX chipset and doesn't support SDRAM, this particular board was good value at the time. Since then of course, the technology has moved ahead and now, six months later, you would probably choose one of the later models that does support SDRAM.

The processor

Everywhere you go these days you

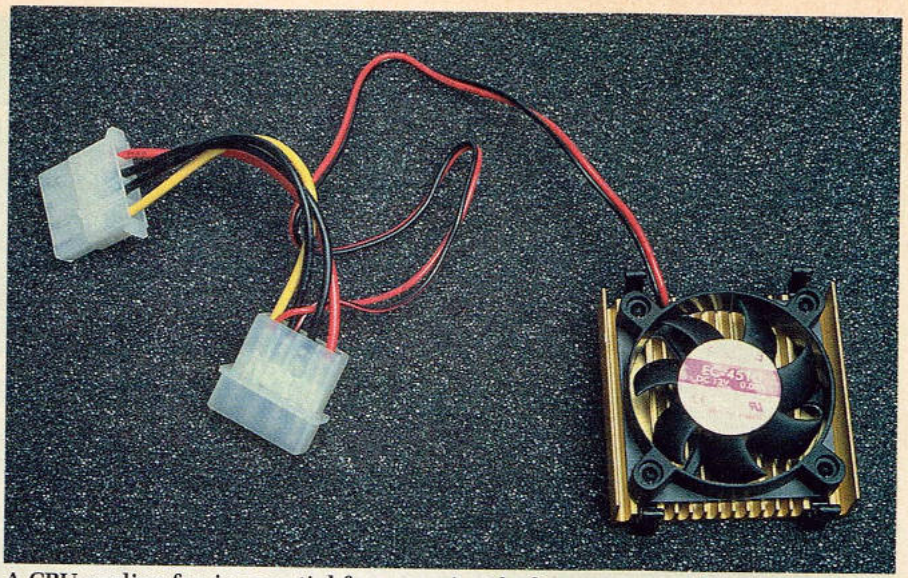
hear about the marvels of the Intel Pentium processor. They're even advertising the things on TV! Until now, all my computers had been based on Intel processors but there was a new kid on the block which was getting a lot of attention.

AMD, a company formed by former Intel staffers, had produced a number of "clone" chips over the years with little success. But its newest offering, the K6, seemed to outperform the equivalent Pentium in just about every test I had read. Just as importantly, the K6 offered the MMX, or "Multimedia Extension", capabilities which Intel had fairly recently started including.

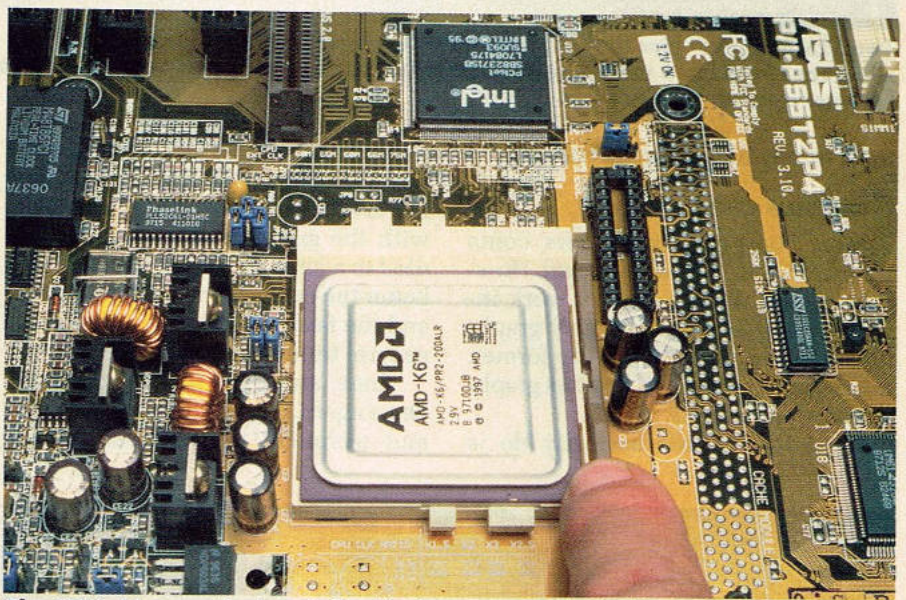
If the K6 outperformed the Pentium, how did the price stack up? It took a bit of digging when I first started this project (about six months ago) but eventually I found a couple of suppliers who handled the K6. And, at the time, it was significantly cheaper than the Pentium equivalent.

That quickly made up my mind. My new PC would have a K6 processor. That decision was the easy part. Getting my hands on one of the little beasties proved a lot more difficult! No-one had, or could get, stock. A lot of people advertised them but all had the same story: sorry, weeks away.

I don't know how many phone calls I made but in the end, perseverance paid off. Eventually, I found a supplier who had one available because of a cancelled order. Did I want it? I drove across Sydney to make sure I got it!



A CPU cooling fan is essential for removing the large amount of heat generated by high-end CPU chips. It comes complete with a male and female power plug adaptor which allow a quick series connection to an existing power cable.



The CPU chip must be inserted with the correct polarity if you don't want to see several hundred dollars go up in smoke – literally. No force is required to insert the chip – it is locked in place after insertion by pushing down on the lever shown, hence the name Zero Insertion Force (or ZIF) Socket.

Memory

The price of memory today is a fraction of what it was even last year. That's good news because most applications today appreciate every last byte of memory you can throw their way. In fact, some applications I use regularly won't even wake up with 16Mb of memory. They want 32Mb and are even happier with 64Mb or more.

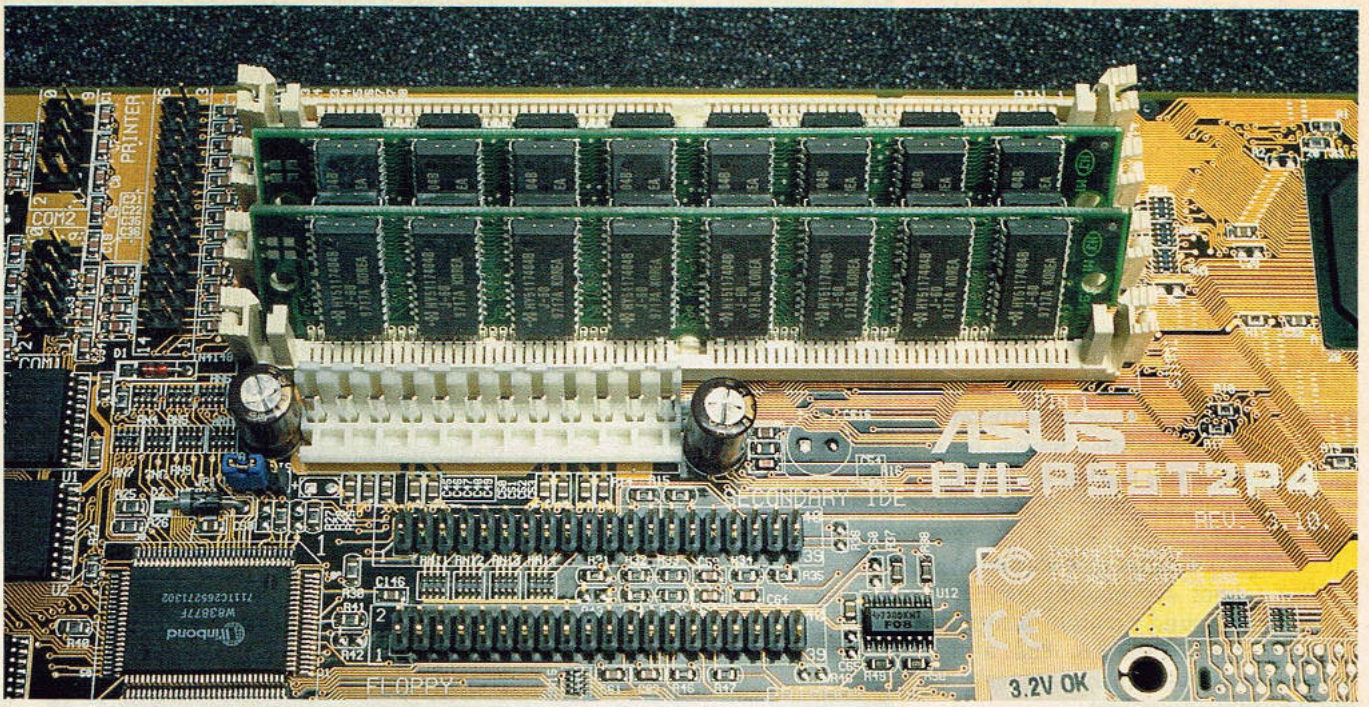
Unfortunately though, the price of memory doesn't increase pro-rata with the amount of memory. 16Mb sticks cost around $90 and 32Mb sticks around $180. But 64Mb modules cost $600, a price increase that's closer to exponential! Therefore, until the price of large memory sticks drops even further, I'll have to settle for the smaller sticks.

Note that on this type of motherboard, there are four memory sockets in two banks. Each socket in a bank must be filled with the same type of memory – eg, 2 x 8Mb for 16Mb. The other bank can have different sticks (as long as both sockets in the same bank have the same memory).

In my case, I used 2 x 32Mb sticks to achieve the 64Mb I wanted. Of course, I could have chosen 4 x 16Mb but this would have meant my future options were cut off. As mentioned above, I really want more memory but having all four sockets filled would have meant throwing memory away in the future.

And that led to frustration No.2. You'd think that memory would be pretty easy to get, wouldn't you? Not so! When I finally placed an order, I was told that the wholesalers were out of stock of 32Mb modules and weren't getting any more for a week or so. "We have plenty of 16Mb modules, though".

A few phone calls to other suppliers turned up the same story so I had



Two 32Mb "sticks" give the computer 64Mb of memory. These were inserted into the Bank 0 sockets, while the two Bank 1 sockets were left empty. That's for future expansion if and when memory becomes even more affordable.

to sit on my hands for several days!

Graphics card

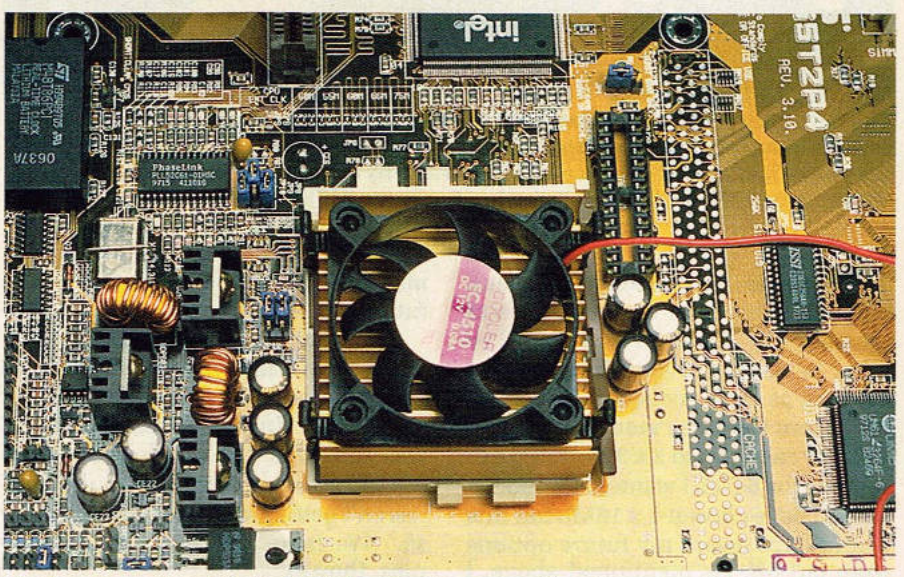
Most "bargain" computers come with a fairly basic graphics card. However, if you do any serious work involving graphics or even play graphics-intensive games (I do the former, not the latter) you need a go-fast graphics accelerator card.

What these cards basically do is free the computer's CPU of a lot of its housekeeping tasks. The CPU is then left to do the work it's supposed to do, with the graphics management handled to a large degree by the card. The better the card, the more it can handle and the faster the machine, at least in general terms.

There are a lot of cards around. Once again, after reading the reviews and technical information, I made what I believe is a very good choice: the Matrox Millenium II. The model I purchased has 4Mb of memory (WRAM) on board, with provision to expand this to 16Mb. That's a lot of video memory but would be quite worthwhile for some applications. The one big sticking point is cost: you can put 64Mb of DRAM into your computer for a lot, lot less than you can put 16Mb of WRAM on the graphics card.

As you can see, the choice of components for my computer upgrade has been a compromise all the way through. Given a blank cheque, I would simply buy the very latest 300MHz Pentium II machine with 384Mb of memory. But like most of our readers, blank cheques don't come my way very often!

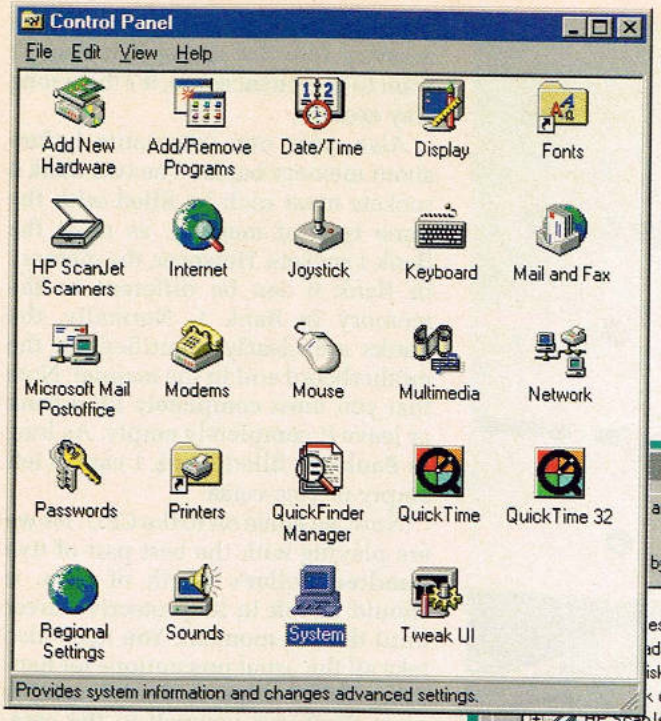
Anyway, after a few phone calls and some running around, I now had the motherboard, the graphics card and the CPU. The new memory turned up a week later and I was ready and raring to go.



The fan was oriented so that it blows air across other heat-sensitive components on the motherboard. This particular fan clips onto the CPU; other fans latch onto the lugs visible on the ZIF socket.

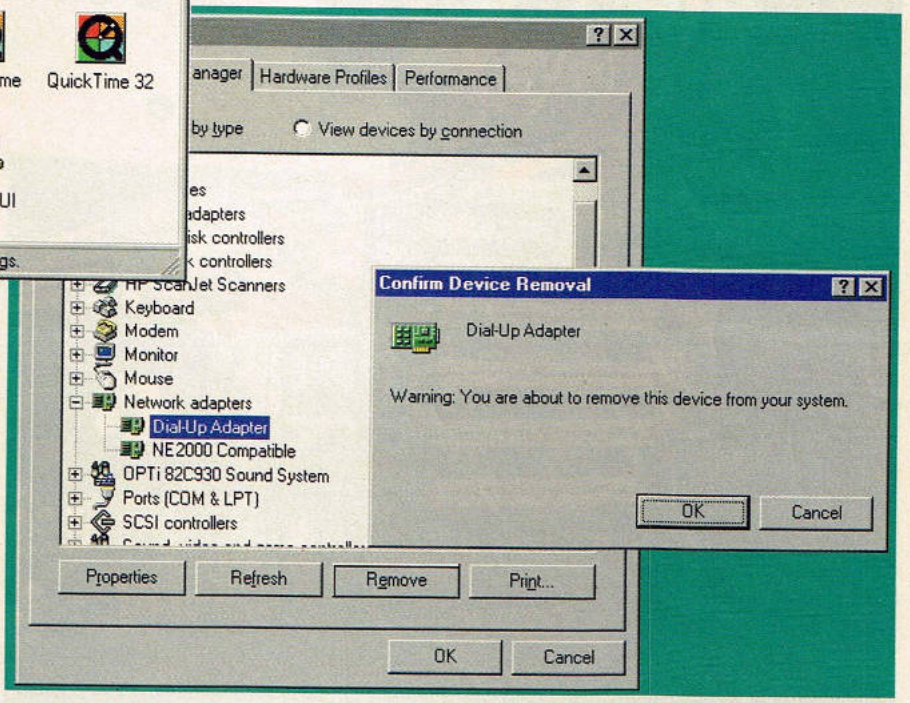
Out with the old

The first step is to disassemble the existing computer. Before you start attacking it with a screwdriver though, you need to let your computer know it's about to have a transplant. Yes, the computer has a brain – but it's not that clever!



LEFT: the "System" Icon in your control panel (click Start, Settings, Control Panel) opens up the path to all the information about your particular computer.

BELOW: removing devices drivers (as distinct from physically removing the devices) from your computer is easy: just highlight the item to be removed and then click the Remove tab. A confirmation box comes up to make sure you *really* want to do it because it's a pretty radical step! Click on OK and the device no longer exists.



Every time you turn on your computer, it "knows" what it has inside it. When you add new hardware, you need to load drivers to make that hardware work. That information stays on the hard disc and is loaded when the computer is "booted".

Making wholesale changes to hardware - especially the motherboard – is almost certain to addle the poor computer's brain so it won't know where (or more correctly who) it is! The way around this problem is to first remove all the existing device drivers so that the machine can rediscover its new hardware.

To do this, you first activate the Control Panel (via My Computer or Start, Settings), then double-click the System icon and select the Device Manager tab. This presents you with a list of the devices in your machine and you select each one in turn and click the Remove button.

As far as the computer is concerned, this is a pretty radical step so it double-checks each time to make sure you really want to do it. And, of course, once it's all done, the computer is no longer usable.

The next step is to exit Windows, turn the computer off and remove all plugs from the back, including the power cords. This done, the cover can be removed and the various expansion cards (sound, video, etc) removed by undoing the screws on the backplane. It's important to handle the cards by their edges only, to avoid any possibility of static damage to the onboard components.

Incidentally, I've removed and replaced literally hundreds of cards and motherboards over the years and have never damaged one. No, I tell a lie – there was that time I dropped one on the floor and ran over it with the chair wheel. However, I have never damaged one through static electricity. Of course, there can always be a first time and Mr Murphy says that it will be either the most expensive or the most irreplaceable card that cops it.

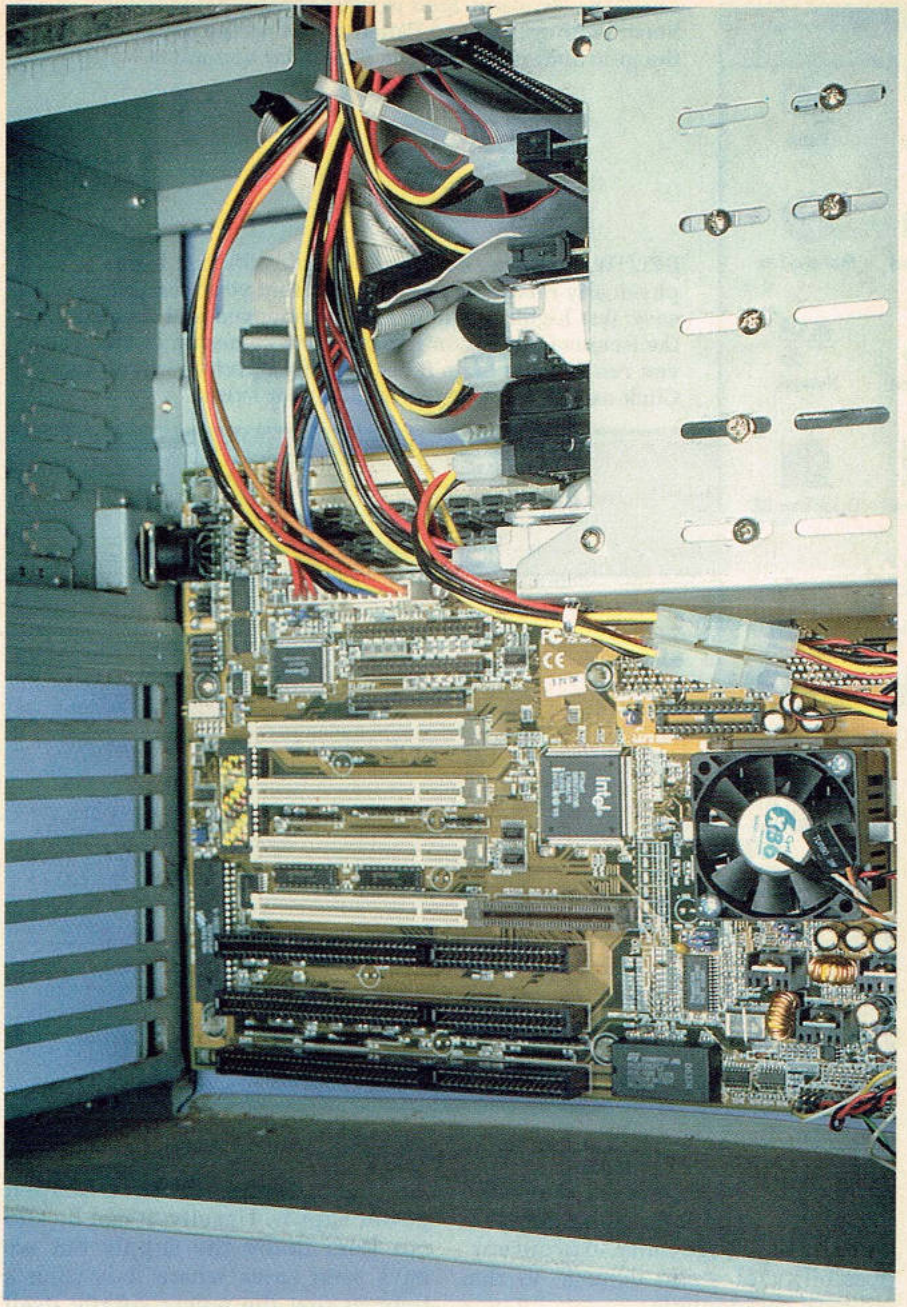
If at all possible, leave any cables connected to the cards in place so that you don t get them back-to-front on reassembly.

In some cases, the motherboard mounts underneath an L-shaped power supply. Usually, it can be slid out from under the supply but we have seen cases where it is such a tight fit that the power supply itself must first be removed. Fortunately, this is quite simple – normally just four screws hold it in place.

Typically, the motherboard will be mounted on a number of plastic pillars held captive in keyed slots and will be secured by a single screw. Once this screw is removed, you simply slide the motherboard towards the edge of the case and then lift it out with its stand-off pillars intact.

Clean the case

If it is more than a year or so old, you will probably find your computer is filthy inside. The fans do a great job of keeping everything cool but they



Here, the motherboard has been mounted in the case, ready to accept the various I/O cards. The difference between ISA and PCI slots is clear: the four white sockets are for PCI cards, while the three black sockets accept ISA cards. Note that we changed the fan pictured on a previous page to one with more power.

also suck in dust. While the computer is disassembled give the case a good spring clean.

Preparing the motherboard

There are only a couple of steps you need to take here: insert the memory, install the CPU; and set any required jumpers on the board. OK, so that's really three steps. I never was good at maths.

First start with the memory. As previously discussed, memory comes on "sticks". These consist of a number of memory chips on a small PC board and are simply inserted into the appropriate sockets on the motherboard. This is usually just a matter of sliding the board into the socket at an angle and then pushing it to near-vertical until it is held in position by two retaining clips.

Note that each memory board has a corner cut-out so that it can only be inserted one way. Never try to force memory into the socket if it doesn't want to go – chances are, it's the wrong way around.

Also note our comments before about memory banks. The two Bank 0 sockets must each be filled with the same type of memory, as must the Bank 1 sockets. However, the memory in Bank 0 can be different to the memory in Bank 1. Normally, the Banks are clearly identified on the motherboard and in the manual. Note that you must completely fill a bank or leave it completely empty. As long as Bank 0 is filled, Bank 1 can be left empty or vice versa.

Now we move on to the CPU. As we are playing with the best part of five hundred dollar's worth of chip, it should be left in its protective cover until the last moment. You must also take all the usual precautions for handling CMOS chips; ie, don't touch the pins, discharge yourself to the case, and so on.

To install the chip, first locate the small dot or slightly angled corner on the CPU – this aligns with a blank area (where one hole is missing) on the motherboard socket. Most sockets used these days are ZIF (Zero Insertion Force) types. These have a little lever alongside the socket which is unclipped and raised to allow the CPU to be inserted. It is then lowered and locked to hold the CPU captive in the socket.

When the lever is raised, the CPU should drop easily into the socket. Because of its pin layout, the CPU can only go in one way, so you can't get it wrong unless you're completely hamfisted and force it in so that one pin is bent over.

High-end CPUs such as the K6 or Pentiums require forced air cooling, so that they don't run too hot. This is achieved via a miniature fan which clips to either the CPU or to the socket underneath.

Smear some heatsink compound on the fan heatsink before you place it on the chip and then lock the connecting clips into place. The fans which clip to the CPU have tiny levers which are squeezed together to force the clips apart. The fans which clip to the socket have a one-piece clip which mates with lugs on the socket.

Either way, mount the fan so that its airflow is directed across any heat-sensitive componentry on the mother-

board – on the new motherboard we selected there were several components with heatsinks attached immediately alongside the CPU socket. Refer to your motherboard manual if unsure.

The fan's power is supplied either from an adaptor plug/socket set which attaches to one of your power supply plugs or, in some cases, via a dedicated power socket on the motherboard. If it is the latter, connect the fan now. Otherwise, leave it until final assembly.

Setting the jumpers

There are several sets of jumpers on the motherboard which must be set according to the speed and type of your CPU.

One important setting is for the CPU voltage – get it wrong and you could damage the CPU. You will need to determine the correct setting from either the CPU itself, from documentation that comes with it or from documentation that comes with the motherboard.

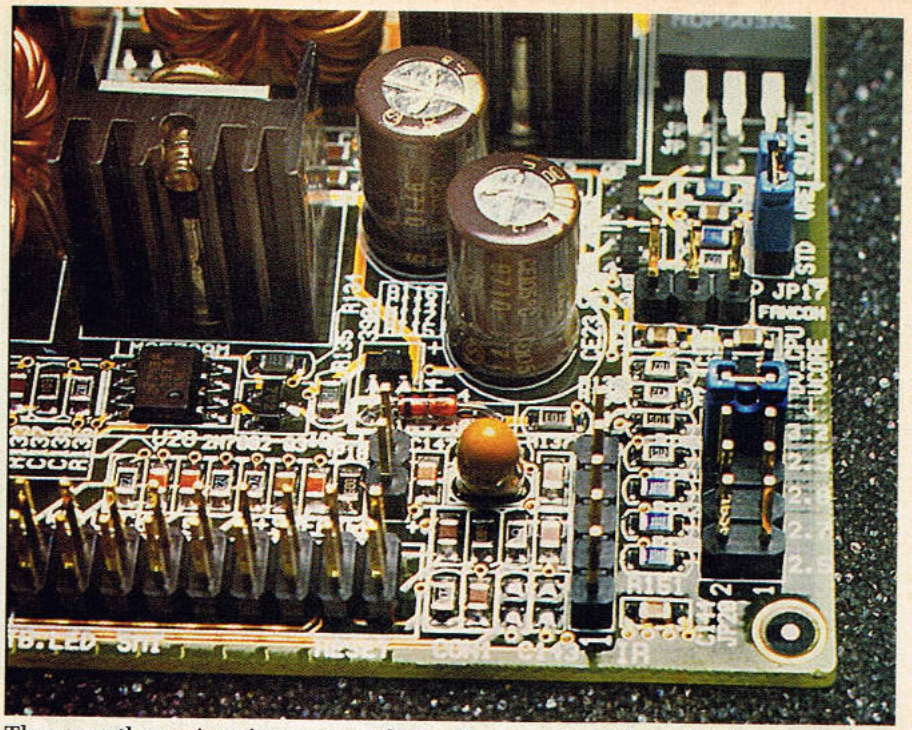
In our case, the correct voltage for a K6 (2.9V) was printed on the chip. In addition, a sticker was included with the motherboard, because the manual made no reference to a K6 chip (the K6 was released after the motherboard).

Another two jumpers are used to set the bus frequency and the bus ratio. Most motherboards today can be set to run at a bus frequency of 50MHz, 60MHz or 66MHz, with the CPU running at a multiple of this frequency (the bus ratio). For example, a 200MHz CPU runs on a 66MHz bus with a bus frequency ratio of 3 (ie, 66 x 3 = 200 or thereabouts).

It's just a matter of setting one jumper to select the bus frequency and the other to select the bus ratio, to set the speed at which the CPU runs. The details will all be listed in the manual for your motherboard.

Incidentally, don't be tempted to run the CPU at a speed higher than its designated rating – eg, a 100MHz CPU at 2x on a 66MHz bus (equivalent to 133MHz CPU) or even 2.5x. While this sometimes appears to work, the CPU was never designed to run at this speed and often fails through overheating. The system will also be crash-happy.

Other jumpers on the motherboard may also require changing, depending on your particular setup. There's only one way to find out and that's to carefully go through the manual.



There are the various jumpers on the motherboard which need to be checked and/or set. Go through the manual carefully to find out what's required.

Reassembly

As you might expect, reassembling the case is basically a matter of reversing your disassembly steps. But (there's always a but, isn't there?) your new motherboard may well be a different size to your old one. Fortunately, the mounting hole locations are standardised and you should have no problem there. To be sure, place the motherboard in the case and check the line-up.

The standoffs will have to be removed from your old motherboard so you can use them on your new one. To remove them, grip their tops with needle-nosed pliers and push them through the board.

Some motherboards have an edge-mounting standoff. This prevents the board from flexing, especially when cards are inserted into the slots. My old board had one of these but the components on the new board were too close to the edge to fit this standoff. Other types of standoffs you might find used include blind types which do not fit into holes in the case but again are designed to keep the board straight. If you have a hole on your motherboard which doesn't seem to mate with a hole in the case, a blind standoff might be called for.

Card insertion

What's this? Your old cards don't match the slots on your new motherboard?

Over the past few years there have been several standards for slots: 8-bit ISA, 16-bit ISA, VESA and PCI to name but a few. Older cards are more likely to be ISA and most new motherboards normally have at least three ISA slots and almost invariably they will be 16-bit. Any 8-bit ISA cards you want to use can be simply plugged into half of a 16-bit slot.

VESA cards won't fit into anything but VESA slots and new motherboards don't have VESA slots, so these cards will have to be replaced. Fortunately, the majority of cards these days are much cheaper than they once were.

If you are buying new cards, PCI will give you the best performance and compatibility. However, note that some cards are only available as ISA types.

Before inserting the cards, take a few minutes to plan their location. You can either end up with a dog's breakfast of cables going hither and thither, or you can make it logical and neat. Naturally, the more drives, etc you have, the worse cabling will be.

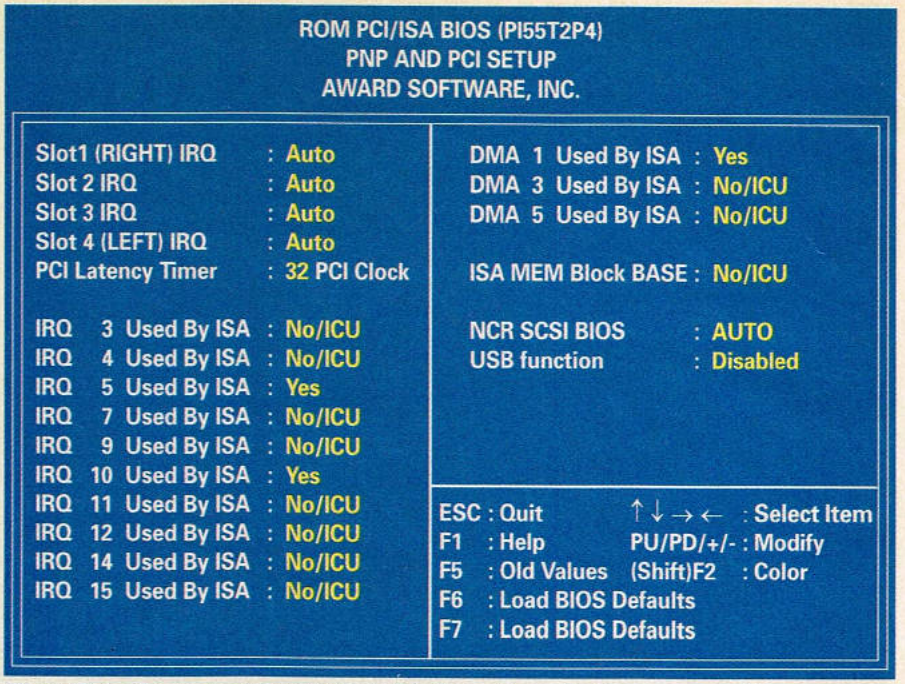

ROM PCI/ISA BIOS (PI55T2P4)
PNP AND PCI SETUP
AWARD SOFTWARE, INC.
Slot1 (RIGHT) IRQ : Auto
Slot 2 IRQ : Auto
Slot 3 IRQ : Auto
Slot 4 (LEFT) IRQ : Auto
PCI Latency Timer : 32 PCI Clock
IRQ 3 Used By ISA : No/ICU
IRQ 4 Used By ISA : No/ICU
IRQ 5 Used By ISA : Yes
IRQ 7 Used By ISA : No/ICU
IRQ 9 Used By ISA : No/ICU
IRQ 10 Used By ISA : Yes
IRQ 11 Used By ISA : No/ICU
IRQ 12 Used By ISA : No/ICU
IRQ 14 Used By ISA : No/ICU
IRQ 15 Used By ISA : No/ICU
DMA 1 Used By ISA : Yes
DMA 3 Used By ISA : No/ICU
DMA 5 Used By ISA : No/ICU
ISA MEM Block BASE : No/ICU
NCR SCSI BIOS : AUTO
USB function : Disabled
ESC : Quit
↑↓→← : Select Item
F1 : Help
PU/PD/+/- : Modify
F5 : Old Values
(Shift)F2 : Color
F6 : Load BIOS Defaults
F7 : Load BIOS Defaults

Fig.1: if you have non Plug'n'Play ISA (legacy) cards, then you need to reserve their IRQ assignments in a section of the CMOS setup labelled "PnP and PCI Setup" (or similar), as this screen mock-up shows. This prevents a PNP operating system such as Windows 95 from attempting to assign those IRQs to PnP cards. In this case, IRQs 5 and 10 have been reserved for ISA non-PnP cards.

But at least plan it to look as good as it can be.

When inserting cards, make sure that they are fully inserted into the slot at both ends. They sometimes look like they are in, but one end is not quite seated. At best, the card won't work. At worst, you could do some damage.

Always make sure the card is secured to the backplane with the appropriate screw. And if you manage to drop a screw onto the motherboard, make sure you fish it out immediately. Don't put it off until later – it's easy to forget and could easily short components or tracks together later on.

Traps for young players

The major problem people have when assembling (or reassembling) a computer is the cabling. Would you believe it was also the only problem I had? And that was after having done this job many times before – and being wary of the problem!

The first job is to fit the power plugs to the motherboard. There are two plugs which must be inserted the right way around. Simply remember that black goes to black – there are black wires on both plugs and these go together. The plugs insert one way around only and as long as black goes to black you'll get it right.

If you haven't removed the plugs from your cards, you shouldn't have any problems. But if you have, be aware that most cables with IDC plugs can be inserted two ways: (1) the way that works; and (2) the way that doesn't!

Almost invariably, pin 1 is the pin with the red stripe. And usually (though not always), pin 1 is marked on the motherboard. If it isn't you may need to refer to your manual.

Finally, make sure that all cables are seated completely. This is where we got into trouble: none of the CD-ROM drives worked when the machine was turned on. After much frustration, it turned out that the connector was lifted very slightly off the motherboard socket at one end, which meant that some of the pins weren't making contact. It looked OK but it wasn't – pushing the connector hard on solved the problem.

Setting up the system

If you have only swapped the motherboard and left everything else basically intact, you shouldn't have to go through the rigmarole of reinstalling Windows 95. However, if you change hard discs at the same time, then you will have to reinstall the operating system on the new disc. These days, you don't have to tell the CMOS what your hard discs are – with modern motherboards, they are auto-detected!

A modern motherboard will have a "Plug'n'Play" (PnP) BIOS. When it was first introduced, this earned the nickname "Plug'n'Pray" because it didn't always work exactly as it should. These days, though, a PnP BIOS generally works quite well, although some of the cheaper expansion cards can sometimes cause problems.

However, most problems with PnP occur when you mix old style (ie, "legacy") ISA cards and PnP cards. Legacy cards are cards on which you manually set the IRQ (interrupt request) assignment and any other resources required by the card (eg, the memory I/O range). This can be done by using on-board jumpers or by means of a software setup utility.

The problem is that a PnP operating system such as Windows 95 doesn't automatically detect any IRQs that have been set in this manner. As a result, it may try to automatically assign an IRQ that has been taken by a legacy card to a PnP card. The result is a resource conflict with either one or both cards not working properly.

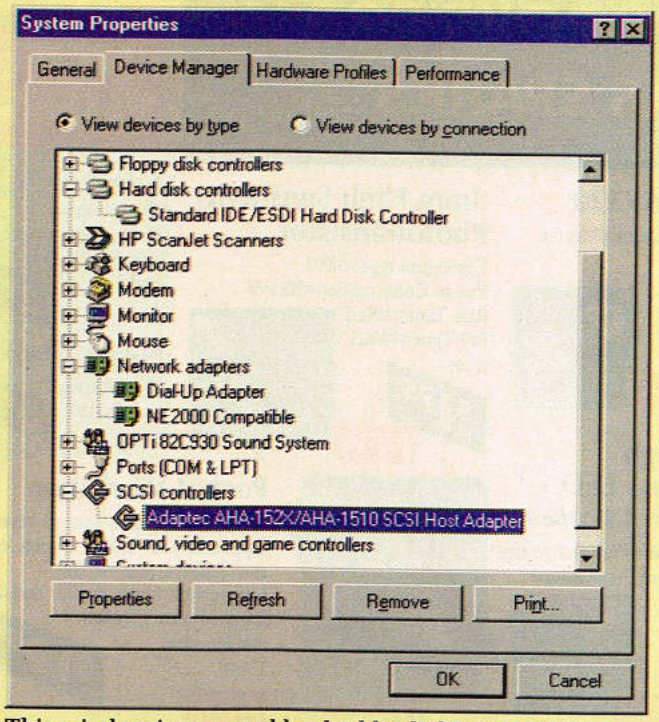
Reserving IRQs

Fortunately, there's any easy answer to this problem. The trick is first write down the IRQs that have been assigned to the legacy cards and then go into your CMOS setup and reserve these IRQs so that the operating system cannot grab them. You normally do this via a section of the CMOS labelled "PnP and PCI Setup" or similar – see Fig.1.

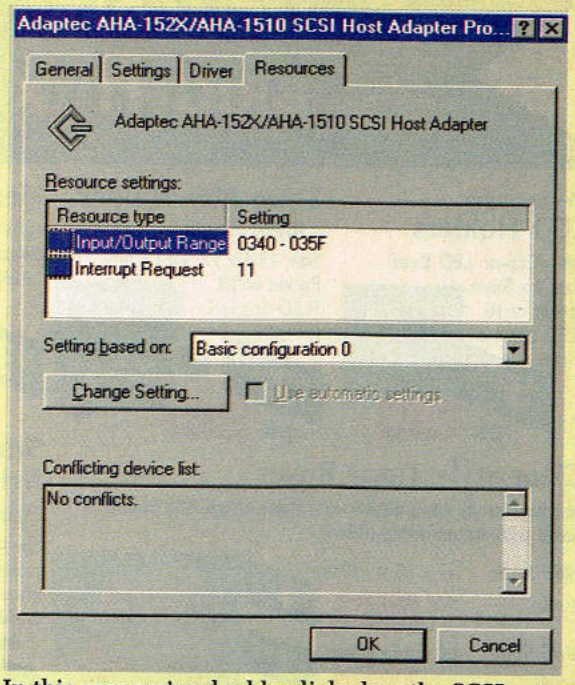
For example, if you install a legacy ISA card that requires IRQ 10, then you change the setting for the line "IRQ 10 Used By ISA" from "No/ICU" to "Yes". Note that the screen mock-up shown in Fig.1 is for an Award BIOS. Your BIOS may show a somewhat different arrangement but the basic principle is still the same.

Note that you may also have to reserve DMA channels for legacy ISA cards (especially sound cards). Check the manual for the device to find out its requirements.

Once the IRQs have been reserved,



This window is accessed by double clicking the System Icon then the Device Manager tab. It presents you with a list of everything in your computer – as far as your computer is concerned. Double clicking on any item with a "+" symbol reveals the individual devices being controlled, along with any conflicts.



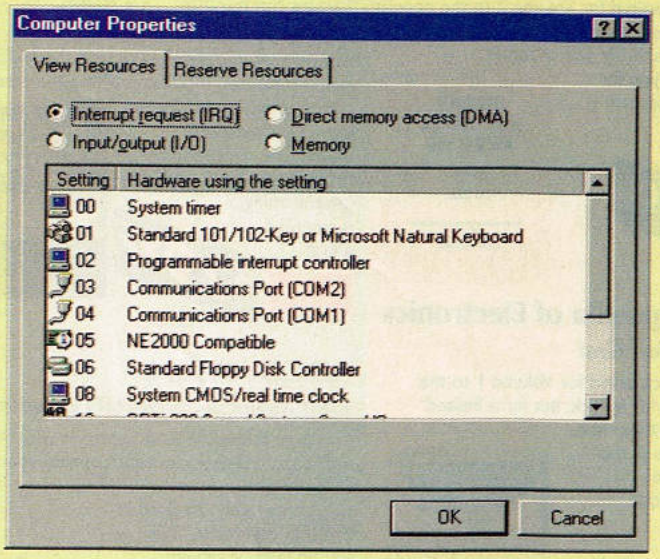
In this case we've double-clicked on the SCSI Controllers entry to reveal all the information we need to know about our SCSI controller; ie, its settings, the driver it uses, addresses, IRQs and so on. Fortunately, we have no conflicting devices but if we did, this screen would show them.

the remaining IRQs will be automatically assigned to the PnP devices and there should be no conflicts. To check this, open Control Panel (via "Start" and "Settings") and then double-click the System icon. Select the Device Manager tab and you will see a list of devices in your machine. If there are any conflicts, you will see a yellow exclamation mark next to the particular device.

If any devices are conflicting, click the Details button to find out which device is causing the problem. If you haven't reserved the IRQ for the legacy card in the system BIOS, then doing so should solve the problem. Alternatively, try setting the legacy card to an unused IRQ and don't forget to reserve this in the system BIOS so that it cannot be grabbed by another card that's added in later.

Note that there are some IRQs which are used by certain devices by convention. If at all possible, these conventions should be maintained to avoid future conflicts.

Finally, if you get yourself into a mess, try starting off with a "barebones" system (ie, as much as you need to get the computer started) and then add the expansion cards in one at a time. Get each card going properly before adding the next. Provided you approach the job in a methodical manner, you should be able to get everything up and running without too many hassles. **SC**



Double Click on the Computer Icon in the System Properties window and you can see which interrupt request (IRQ) assignments are used in your computer, and by what. You can also check the I/O (input output) settings, DMA settings and the memory being used by that device.

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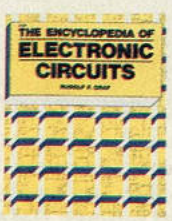

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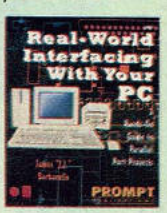

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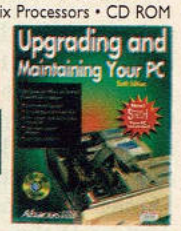

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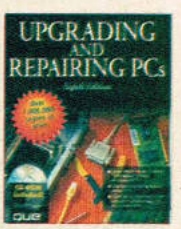

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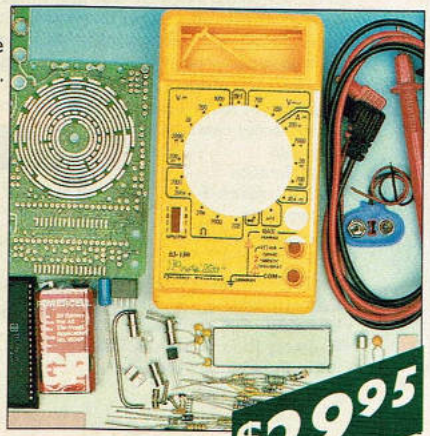

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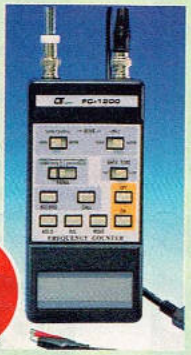

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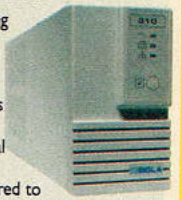

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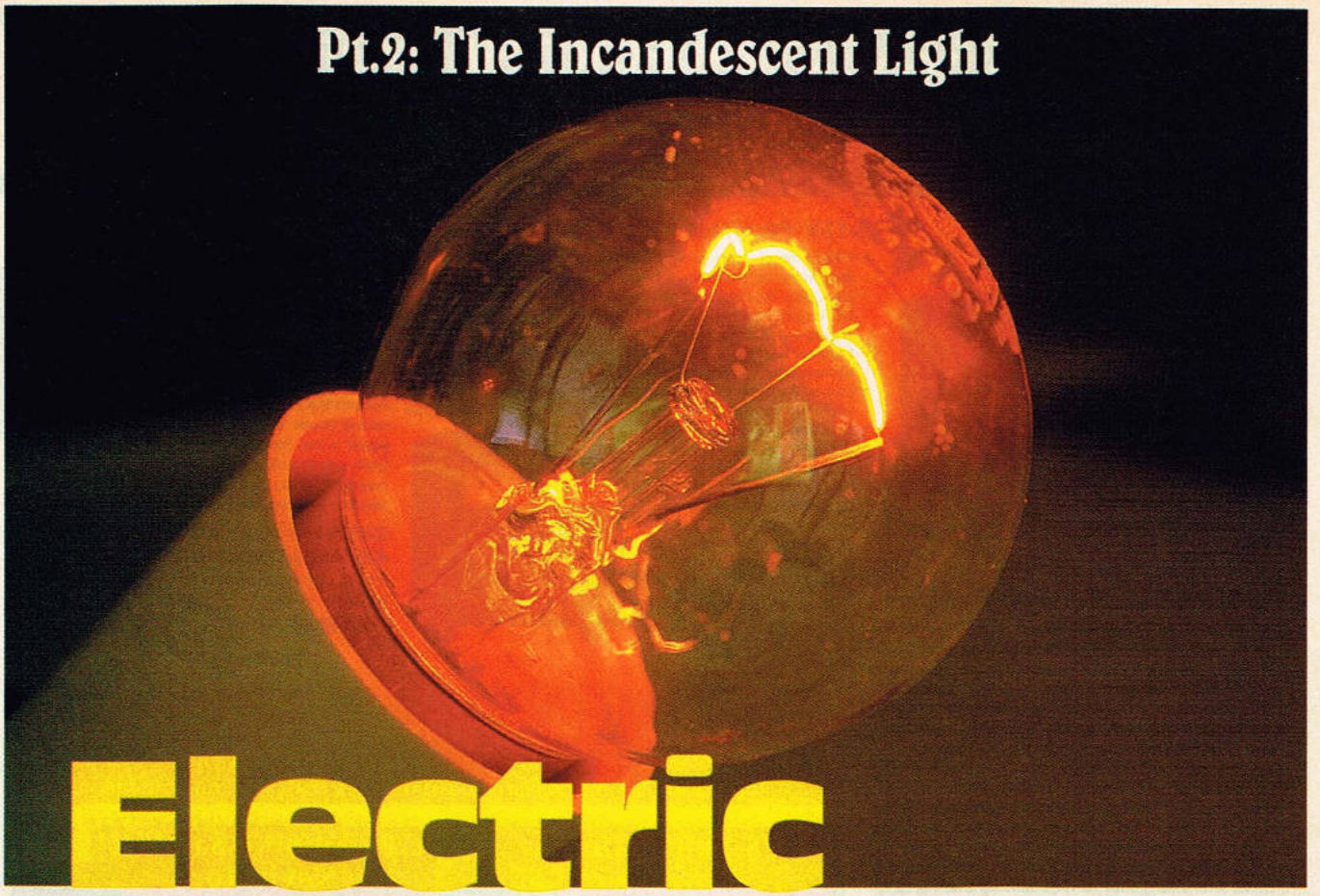
Pt.2: The Incandescent Light



Electric Lighting

The development of the electric light took many years and took researchers down many false trails along the way. This month, we look at the early research and describe the different types of incandescent lamps.

By JULIAN EDGAR

The incandescent lamp is the oldest electric light source still in general use. Early attempts at constructing electric incandescent lights were made in the 1840s and Joseph Swan experimented with carbon-filament evacuated-glass incandescent lights in the 1860s. However, it was Thomas Edison who made real progress in the years from 1878.

Edison understood that for the electric lamp to be successful, he needed to do more than just invent a viable lamp. The organisation of the electricity supply infrastructure was vital to the success of electric light and Edison decided to model much of his approach on the methods used by the gas industry. This meant that he would call his electric lights "burners", that each "burner" would have a power similar to a standard gas lamp, that each light needed to be independently operable (ie, wired in parallel), and that each consumer's usage would be recorded on a meter to be read monthly. It was this "big picture" approach that gave Edison a substantial advantage over competitors such as Joseph Swan.

Edison's work on the electric light bulb initially set off in the wrong direction, based as it was on the use of platinum filaments. Platinum was expensive and the temperature at which

it becomes incandescent is very close to its melting point. However, he soon rediscovered Swan's idea of using carbonised fibres, initially thread and then later bamboo.

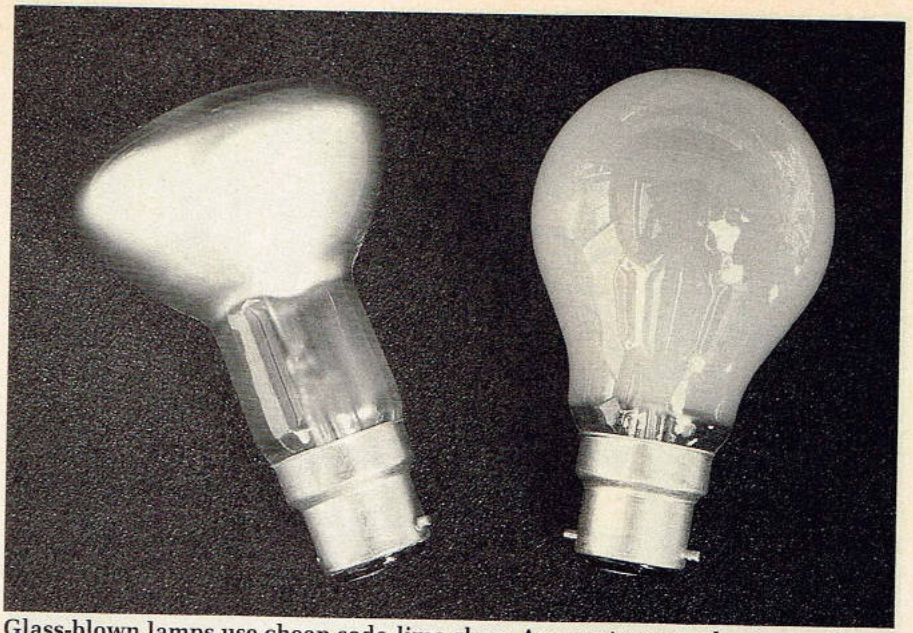
By October 1879, Edison had developed a carbon filament that had a resistance of 140Ω and which would burn for 13 hours. Having convinced himself that somewhere in the world there existed the ideal bamboo for the manufacture of carbonised filaments, Edison despatched agents to Japan, China, the West Indies and Central America. Even the upper reaches of the Amazon were scoured for the best bamboo. All attempts were ultimately unsuccessful.

Electric lamps using carbonised filaments were the mainstay behind the early commercial success of electric lights but the output of such lamps was relatively low. In 1883, a squirted-cellulose filament was adopted, giving a small but useful increase in luminous efficacy. This filament was initially made by forcing a solution of nitrocellulose in acetic acid through a die. This was coagulated in alcohol and the continuous thread that was formed was washed and then denitrated with ammonium sulphide. The thread was then carbonised. Incidentally, the research on making filaments in this way later led to the discovery of artificial textiles early this century.

Even though carbonised filaments had an efficacy of just 1.68 lm/W (general purpose incandescent lamps of today have an efficacy of 8-21.5 lm/W), production was approaching 100,000 lamps per annum by the end of 1882 in England alone. But although the search for a better filament material proved difficult, the characteristics needed of such a material were easy to define:

(1) it had to be an electrical conductor with a very high melting point;
(2) it had to be relatively cheap; and
(3) it had to be relatively easy to work into filamentary form.

In 1898, a major breakthrough came with the development of a process for making filaments from osmium. But osmium had a number of disadvantages: it was expensive, its low electrical resistance meant that the lamps could not be run at voltages higher than 44V and up to one metre of wire needed to be coiled within a single lamp! Although the use of osmium



Glass-blown lamps use cheap soda-lime glass. Amongst many other types, they are available with an internal reflector (left) and with a pearl finish (right). Pearl lamps use a glass bulb which has been internally etched with acid.

persisted for about another decade (sometimes in alloys with other metals), it was eventually overtaken by other metals. Its name lives on, however, in the brand name "Osram", the trademark of the company which first used osmium.

Tungsten filaments

The next filamentary material that was tried was tantalum. It was cheaper than osmium and had a higher resistance. However, it was tungsten that really made the electric light a practical proposition.

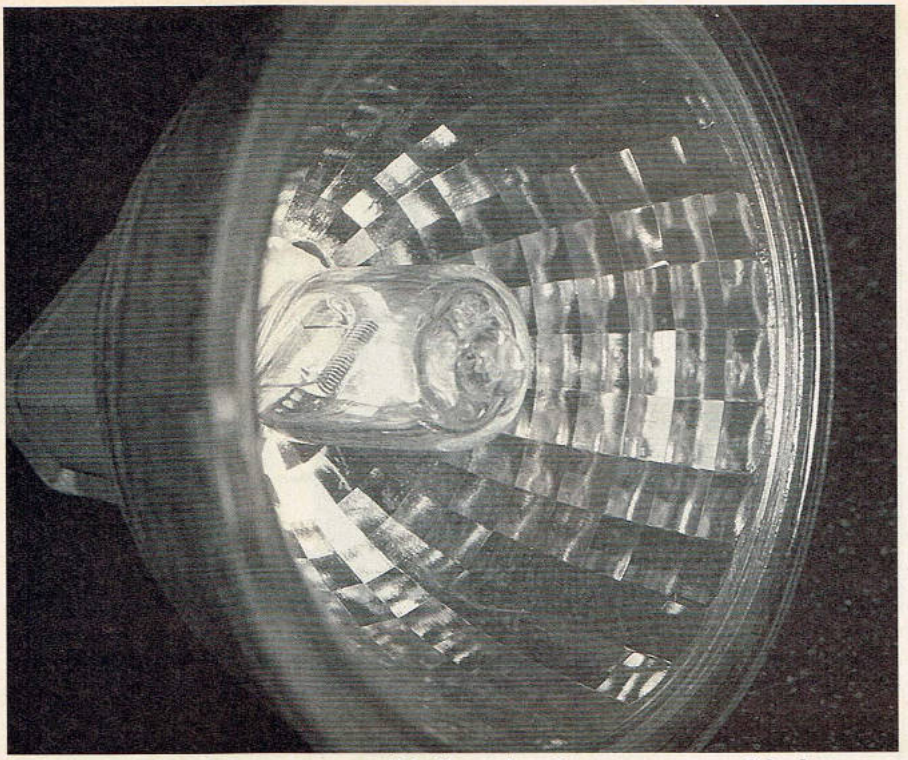
In 1904, two Viennese researchers developed a process for forming tungsten into filaments. The process consisted of evaporating the liquid from a tungsten colloid and then passing a high current through the honeycomb material that had formed. This fused the honeycomb into a pure metal wire. The first tungsten-filament lights appeared on the market in September 1906.

While these developments were taking place in Germany and Austria, General Electric in the US developed the General Electric Metallised (GEM) lamp. This used a metal-coated carbon filament. However, it had a lower efficiency than the new metal filament lamps and so was doomed to commercial failure.

Early tungsten filaments were fragile and costly. The lamps were packed in cotton wadding for shipment but there was still much filament breakage. This problem was eventually overcome in the period from 1906-1910 by General Electric scientist Dr William

Year of Introduction	Type Of Filament	Initial Efficacy (lm/W)	Useful Life (hr)
1881	Carbonised thread of bamboo	1.68	600
1884	Squirted cellulose	3.4	400
1898	Osmium	5.5	1000
1902	Tantalum	5	250-700
1904	GEM (metallised carbon)	4	800
1904	Non-ductile tungsten	7.85	800
1910	Ductile tungsten	10	1000

Fig.1: the sequence of incandescent filament development. (Moralee, D; The Electric Lamp Business in Electronics & Power).



Tungsten halogen lamps use a small bulb so that the temperature of the lamp stays high. This is necessary if the evaporated tungsten is to be returned to the filament, prolonging its life and reducing bulb blackening.

Coolidge, who developed a process for converting crystalline tungsten into fibrous tungsten. Fibrous tungsten is very ductile (it can be drawn into wire) and has five times the tensile strength of steel.

Vacuum pump

Because of oxidation, the presence of air within a bulb leads to an extremely short filament life. The early lamp developers had enormous difficulties in evacuating the inside of the bulb but the invention of a vacuum pump in the late 1860s by German Herman Sprengel helped solve this problem. Edison used Sprengel's pump to evacuate his lamp, noting that it was necessary to continue evacuating the bulb as the filament grew hot. This is because residual gases are released from both the filament and the glass bulb as the temperature rises.

However, even with a better vacuum, tungsten filaments evaporated rapidly, blackening the inside of the bulb and reducing the light output. General Electric scientist Dr Irving Langmuir discovered that even minute amounts of water vapour (as little as 10 parts per million) inside the bulb greatly increased the amount of tungsten deposited on the bulb wall. The addition of inert gases such as nitrogen was tried and it was found that this reduced evaporation significantly. The nitrogen formed a blanket around the filament, retarding evaporation and reducing the ability of the water vapour to pick up tungsten particles.

However the nitrogen also cooled the filament which in turn reduced the light output. To overcome this problem, a longer coiled filament was used which had proportionally less heat loss.

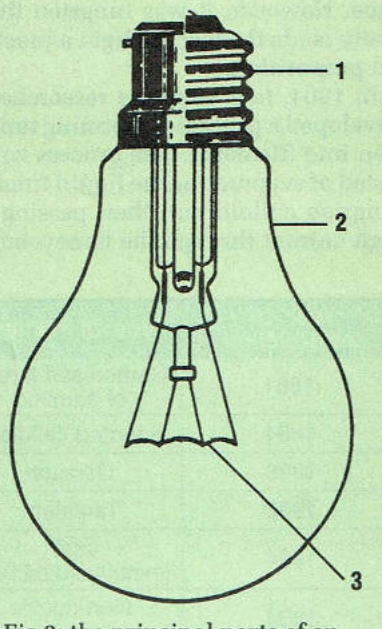


Fig.2: the principal parts of an incandescent lamp. (1) cap; (2) bulb; (3) filament. (de Boer, J; Interior Lighting).

Tungsten incandescent lamps

The principal parts of a modern incandescent lamp are shown in Fig.2. The filament consists of coiled ductile tungsten, with some lamps using a "coiled-coil". A coiled filament presents a smaller effective surface area to the fill gas, thereby reducing heat loss by convection and conduction.

The filament is supported by a glass stem, the lead-in wires and by support wires. The lead-in wires on general-purpose lamps are normally in three parts: (1) the upper part to which the filament is pinched or sometimes welded; (2) the central part which forms a vacuum-tight seal with the lead-glass of the stem; and (3) the lower part which often has a reduced melting point so that it acts as a built-in fuse.

The wires supporting the filament are often made of molybdenum, as this metal is resilient, displays no affinity for tungsten and reduces heat loss.

A glass bulb is necessary to prevent oxygen from coming into contact with the filament. This bulb is filled with argon or an argon and nitrogen mixture. The gas pressure in a general service lamp is about 0.9 atmospheres, rising to about 1.5 atmospheres when the lamp is operating.

The bulbs of most lamps are made from soda-lime glass, the cheapest glass available. These have a maximum bulb temperature rating of 375°C. For lamps that must withstand higher temperatures or temperature shocks, more resistant glasses are used, including pure fused silica for lamps that must meet the highest standards.

The inside of the bulb can be treated in various ways to achieve a special effect. For example, it can be frosted to give a pearl lamp by etching the inside of the glass with acid. Another treatment known as "opalising" involves coating the inside of the bulb with a mixture of finely powdered silica and titanium dioxide. Clear and pearl lamps have the same efficacy,

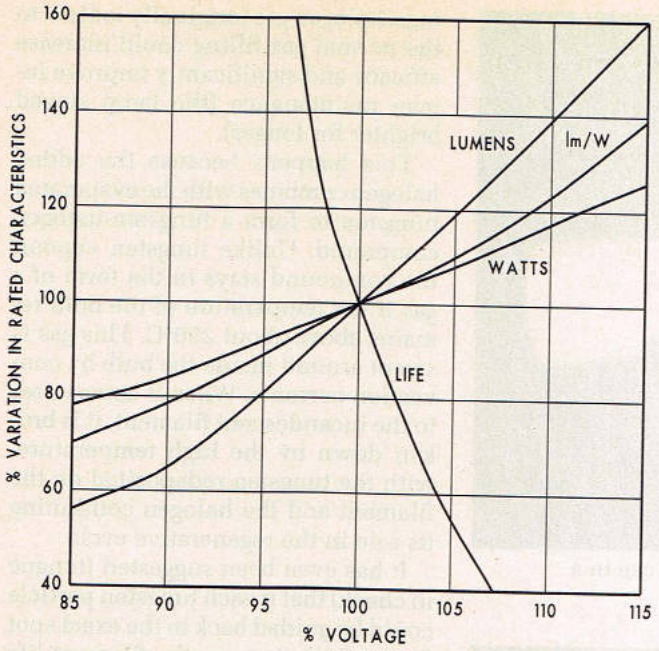


Fig.3: the effect of voltage variation on life, luminous efficacy, power dissipation and luminous flux of an incandescent lamp. (Julian, W; Lighting: Basic Concepts).

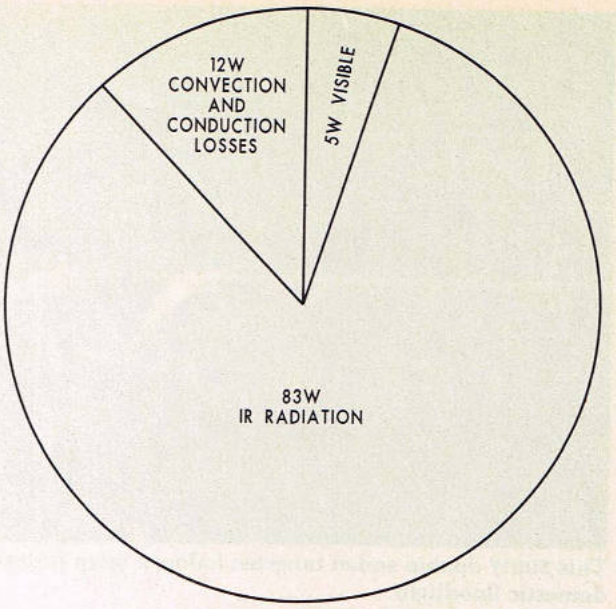


Fig.4: the energy balance of a typical 100 watt general service lamp. Of the 100 watts power input, just 5 watts of visible radiation is produced (source: Philips Lighting Manual).

while opalised lamps have 4-8% lower efficacy.

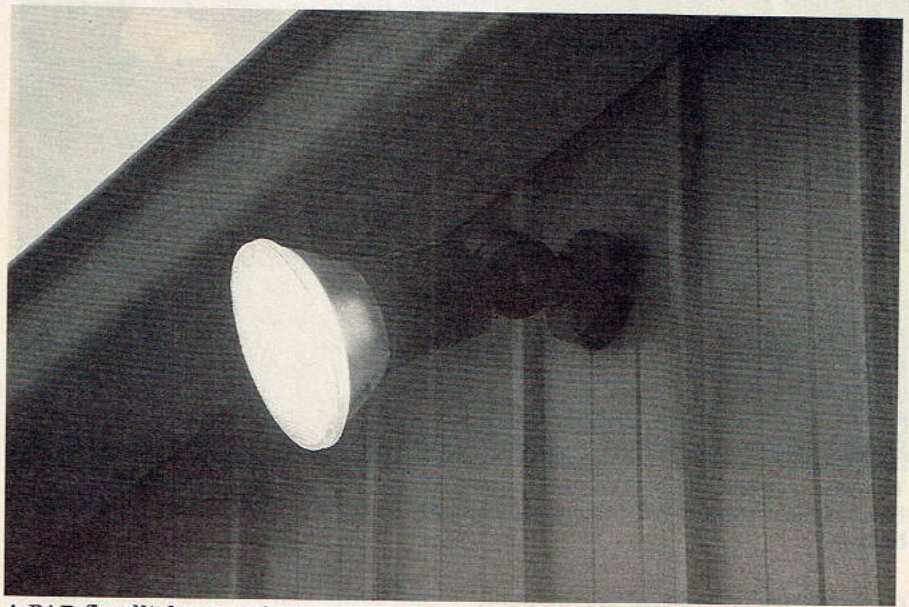
Reflector bulbs of the PAR-type (PAR stands for parabolic reflector) are moulded in two pieces from tough, heat-resistant glass. Part of the inside of the bulb has a reflective coating applied to it – usually vaporised silver or aluminium. Because the internal reflector is not subjected to any damage, corrosion or contamination, cleaning is never necessary and a high light output is maintained.

Glass-blown bulb reflector lamps (ie, bulbs formed by glass blowing) are available with the reflector at either end of the bulb. They are cheaper than PAR reflector bulbs and have a lower luminous intensity than PAR bulbs of the same power. An enormous range of decorative lamps is also available. Candle-shaped lamps, coloured lamps, box-shaped lamps and so on are widely used.

The energy balance of a typical 100-watt general service lamp is shown in Fig.3. Of the 100W of power input, just 5W of visible radiation is produced. Most of the rest is produced as infrared radiation. Infrared radiation from the filament makes up 61W while the bulb produces a further 22W, giving a total infrared output of 83W. Convection and conduction losses make up the remaining 12W.

Theoretically, an incandescent lamp operating at the melting point of tungsten (3380°C) and having no convection or conduction losses could produce a luminous efficacy of 53lm/W. Lamps with a typical rated operating life of 1000 hours have an efficacy of between 8-21.5lm/W.

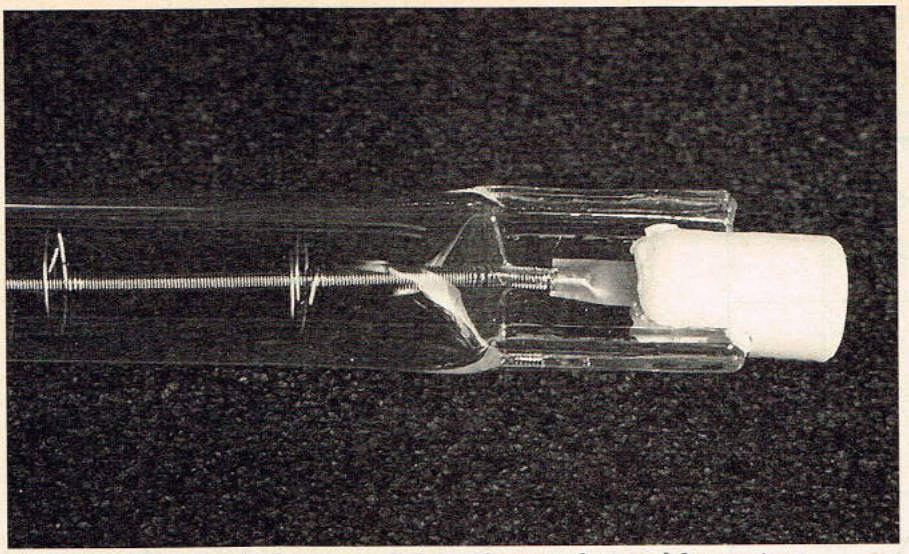
The colour temperature of a typical incandescent lamp is 2800°K, which means that, compared with the Sun, it has a warm, yellow appearance. However, because the radiation emitted from such a lamp covers the entire visible spectrum, its colour rendering ability (Ra of 99-100) is excellent.



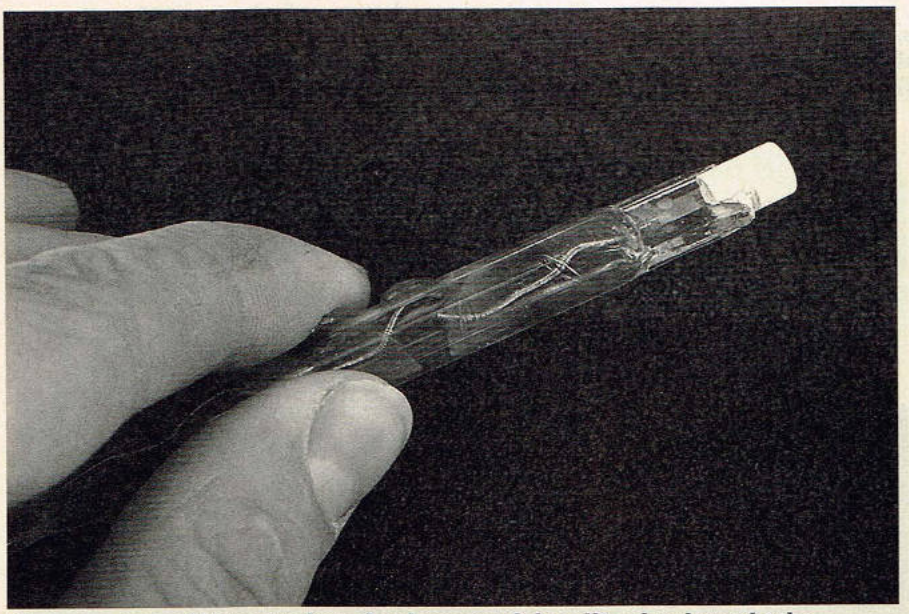
A PAR floodlight is made in two pieces and uses toughened glass to withstand the sudden temperature shocks that occur when it is exposed to rain. Vaporised silver or aluminium is used to form the internal reflector.

Lamp life

In line with popular belief, frequent switching on and off does reduce lamp life. There are two reasons for this: (1) the very high surge currents at switch-on (typically 10 times the lamp rating)



This 500W double-ended tungsten halogen lamp is designed for use in a domestic floodlight.



The same type of lamp as above but here rough handling has brought the filament into contact with the glass, partially melting it. The filament has also broken!

cause thermal stresses in the filament; and (2) these high surge currents have associated magnetic forces which can literally blow a weakened filament apart.

Mains voltage variations also have a dramatic effect on lamp life. If the lamp is nominally rated at 240 volts, increasing the voltage to 250V approximately halves the life of the lamp! However, with that voltage increase, luminous flux rises by 20%, luminous efficacy by 8% and power dissipation by 10%. Fig.4 shows the relationship between these factors.

Note that while normal incandescent lamps can be dimmed, a dimmed light has a lower colour temperature (it is redder than normal) and has a poorer luminous efficacy than an undimmed lamp. In fact, where a lamp is continually dimmed, it is better to replace it with one of a lower wattage.

Tungsten halogen lamps

Tungsten filament lamps blacken because the high temperature of the filament causes tungsten particles to evaporate off the filament and condense on the relatively cold bulb wall. It was not until 1958 that E. G. Fridrich and E. H. Wiley discovered that adding a halogen gas (originally iodine) to the normal gas filling could increase efficacy and significantly improve lumen maintenance (the lamp stayed brighter for longer).

This happens because the added halogen combines with the evaporated tungsten to form a tungsten-halogen compound. Unlike tungsten vapour, the compound stays in the form of a gas if the temperature of the bulb remains above about 250°C. This gas is swept around inside the bulb by convection currents. When it comes near to the incandescent filament, it is broken down by the high temperature, with the tungsten redeposited on the filament and the halogen continuing its role in the regenerative cycle.

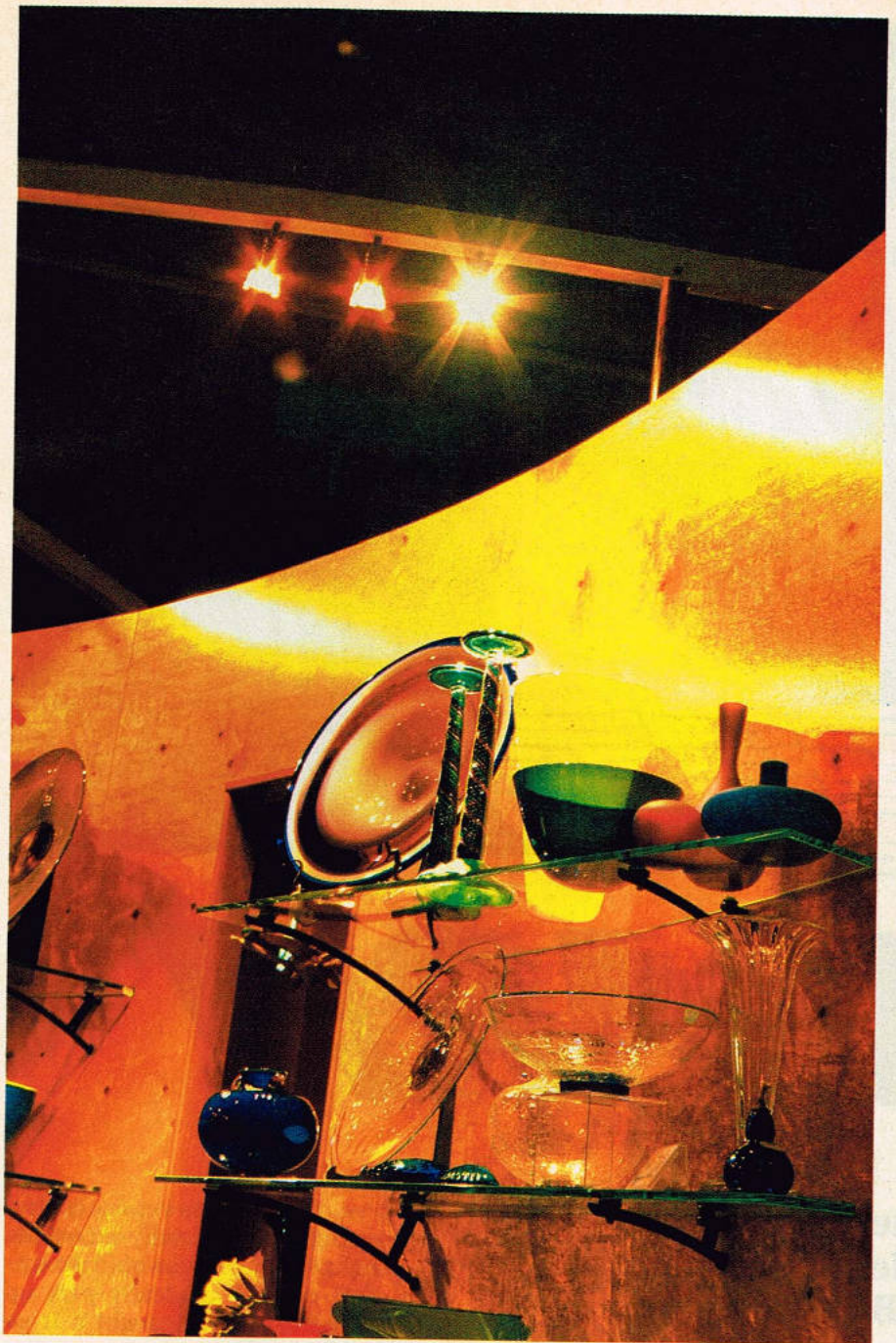
It has even been suggested (tongue in cheek) that if each tungsten particle could be guided back to the exact spot from which it came, the filament life would be infinite!

The operation of a tungsten-halogen bulb is critically dependent on the temperatures of the various parts of the lamp. As indicated, the quartz bulb must be kept above 250°C, while the hermetic seal between the quartz bulb and the molybdenum lead-in wire must be kept below 350°C. Above this temperature, the lead-in wire starts to oxidise, placing mechanical stress on the seal. Furthermore, if the coolest part of the filament is not kept above a critical temperature, corrosion of the filament wire will take place, reducing lamp life.

To maintain a high enough wall temperature, the bulb must be smaller than a conventional incandescent lamp. In addition, the bulb is made of quartz or fused silica to withstand such a high temperature. The stronger bulb wall and smaller volume mean that the lamp can be operated at up to several atmospheres of internal gas pressure, thereby reducing the rate of filament evaporation and thus further prolonging the life of the lamp.

And why must you never touch a tungsten halogen bulb? The reason is that any finger grease deposits left behind on the quartz envelope will cause the surface to develop fine cracks and this will eventually lead to high-temperature failure. Any contamination should therefore be cleaned off with methylated spirits before the lamp is used.

Tungsten halogen lamps have several advantages over ordinary tung-



Small 12V halogen lamps are often used for spotlighting displays in shops.

sten lamps. These include: (1) a much longer life – up to 3500 hours; (2) typically 10% greater luminous efficacy; (3) compactness; (4) a higher colour temperature of 2800-3200°K; and (5) little or no light depreciation with age.

Tungsten halogen lights are available in both mains-powered and 12V forms. Mains lamps are generally of the tubular, double-ended type and are often used for domestic flood lighting. The low voltage types are generally sealed in an exterior parabolic reflector which uses either an aluminium or dichroic multifaceted surface.

Dimming of tungsten halogen lights should be avoided because of the temperature-critical nature of their operation. If a tungsten halogen lamp is dimmed, severe bulb blackening will quickly occur and early filament failure is likely.

In part 3 next month, we shall look at fluorescent lamps. **SC**

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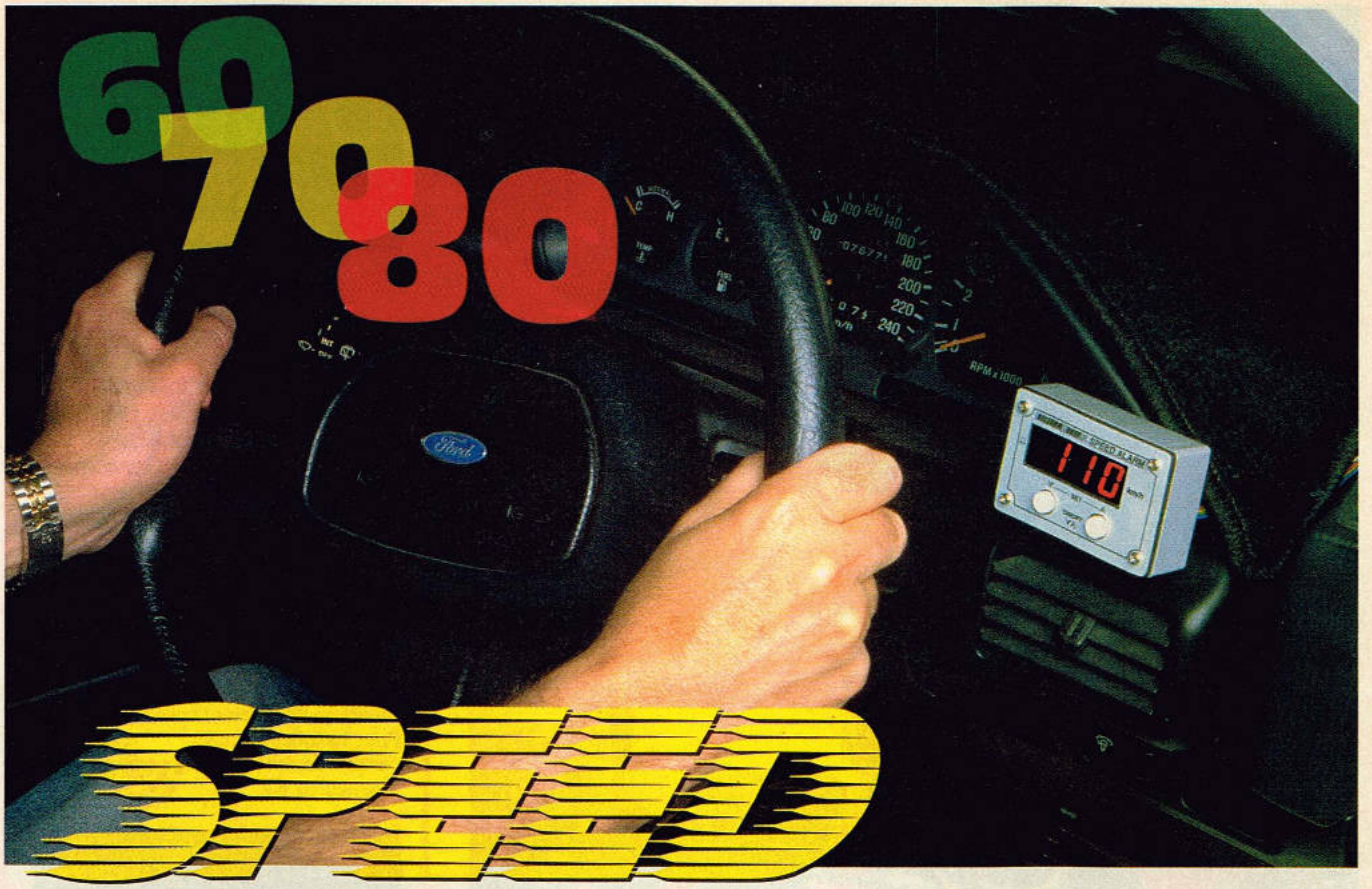


Had a speeding fine lately? Painful, isn't it? And how many more demerit points before you lose your licence? Bit of a worry, eh? Well, this Speed Alarm will help you avoid these worries and make you a safer driver too.

By JOHN CLARKE

In most Australian States, speeding fines are getting to be a real pain in the wallet. In New South Wales for example, exceeding the speed limit by 10km/h presently means a fine of $112 and two demerit points while exceeding it by 15km/h whacks you for $179 and three demerit points. Get a few fines like these over a few months and it starts to run into real money and your licence is looking decidedly shaky too.

And you don't have to be a speed demon either. It's all too easy to let the speed creep up gradually when you are on a long drive and then when you come into a low speed zone, you can be way over the limit.

Even if your car has a cruise control you can still inadvertently exceed the speed limit. On long downhill stretches your car will gradually pick up speed and if you are caught it is no good claiming that you had your cruise control set. The police have heard that story before.

When you consider the amount of money involved in a couple of speeding fines, it is equivalent to quite a few electronic projects you won't be able to build. So think seriously about this speed alarm. It will cost less than being caught for exceeding the speed limit by 15km/h and it could save you lots.

Features

The SILICON CHIP Speed Alarm comprises a small control box with a 3-

digit display, a LED to indicate over speed and two buttons for setting the speed and turning the alarm on or off. One button increases the speed setting in 5km/h steps while the other reduces it in 5km/h steps. Pressing both buttons at once turns the alarm on or off. In fact, the operating concept is exactly the same as the Speed Alarm using in current model Holden Commodores; we copied it, the operating concept that is, not the circuit!

A separate larger box contains most of the circuitry. This can be located under the instrument panel. It connects to a Hall Effect pickup on the drive shaft. Calibration is simple: just tweak one trimpot after the system is installed.

Block diagram

Fig.1 shows the basic arrangement of the Speed Alarm. A small magnet is attached to the car's drive shaft and as it whizzes past the Hall Effect speed sensor it produces one pulse per shaft revolution. A frequency to voltage converter converts the resulting pulse frequency to a voltage and this is applied to one input of a comparator.

The second input of the comparator is fed with a voltage proportional to the Speed Alarm setting. If the voltage produced by the vehicle's speed is greater than the voltage for the Speed Alarm setting, then the comparator switches on the alarm buzzer and lights the alarm LED.

The Speed Alarm setting is obtained from an up/down counter which feeds a digital to analog (D-A) converter.

While the block diagram of Fig.1 shows the basic concept of the Speed Alarm, the actual circuit arrangement is a good deal more complex. Instead of using one up/down counter we have had to use two. One is a BCD (binary coded decimal) type and the other a straight binary type. Fig.2 illustrates the arrangement of these up/down counters and some of the ancillary functions.

Whenever one of the switches is pressed, a diode OR gate (D1, D2)

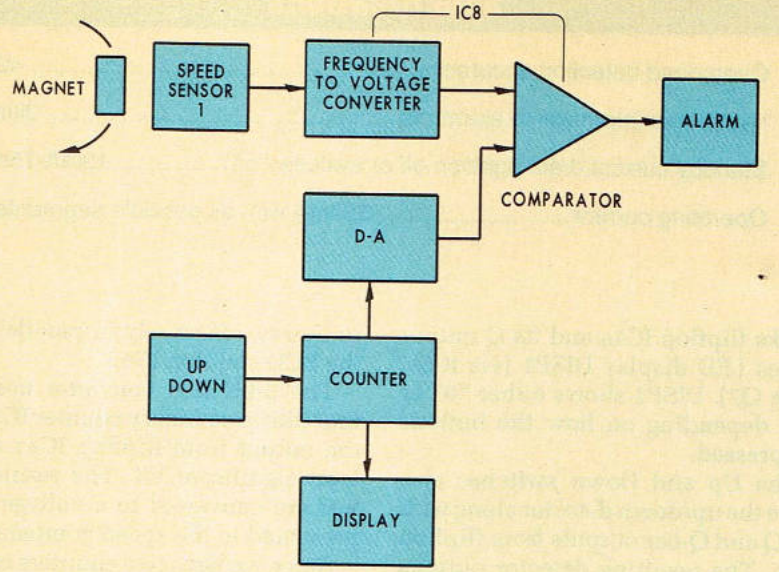
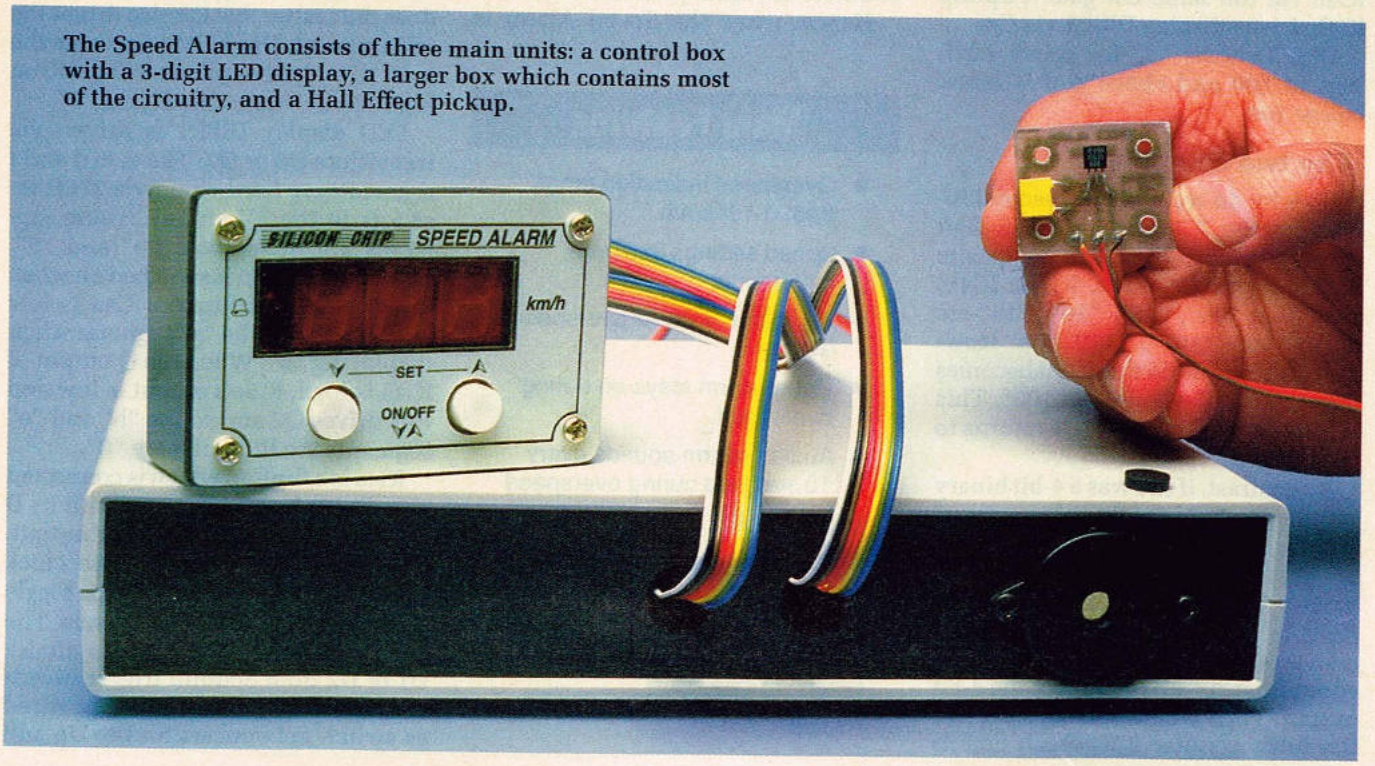


Fig.1: this is the concept of the Speed Alarm. The speed signal from a Hall Effect pickup is converted to a voltage and compared with a speed setting derived from an up/down counter and D-A converter.



The Speed Alarm consists of three main units: a control box with a 3-digit LED display, a larger box which contains most of the circuitry, and a Hall Effect pickup.

Specifications

- Overspeed detection accuracy ..... <2%
- Hysteresis (alarm on to alarm off) 3km/h
- Standby current drain (ignition off or switched off) 10mA-15mA
- Operating current ..... 350mA with all possible segments lit

clocks flipflop IC4a and its Q output drives LED display DISP1 (via IC5c, Q6 & Q7). DISP1 shows either "0" or "5", depending on how the buttons are pressed.

The Up and Down switches also drive the up/down detector along with the Q and Q-bar outputs from flipflop IC4a. The resulting detector outputs drive the clock inputs of both BCD and binary up/down counters. Clocking only occurs when DISP1 goes from "5" to "0" when counting up and from "0" to "5" when counting down. That makes sense because BCD counter IC1 drives the "tens" display, DISP2, via the 7-segment decoder IC2.

BCD counter IC1 counts from "0" up to "9" before returning to "0". The carry output (when counting beyond from "9" to "0") drives flipflop IC4b via a second diode OR gate (D5, D6). When counting down from "0" to "9" the borrow output also drives flipflop IC4b via the same OR gate. Flipflop IC4b drives display DISP3 via Q4.

DISP3 shows "1" for speed readings of 100 and above and is blank below 100.

Why two counters?

So why do we need the second binary counter, IC3? As far as the 3-digit display is concerned, the composite BCD counter (ie, IC4a, IC1 & IC4b) goes from "00", "05", "10", "15" etc up to "95", "100", "110" etc. However, in binary form the count becomes disjointed at the count of "100". This is because BCD counter IC1 returns to "0" after "9".

By contrast, if IC1 was a 4-bit binary counter it would continue beyond "9" (1001) to 10 (1010), 11, 12, 13 ,14 and 15 (1111) before returning to "0" (0000). Since we want the counter to provide a voltage output via a D-A converter, we require a consecutive count from "0" up to "15" for the 4-bit output. Thus we have used a second up/down counter IC3 which counts in binary, effectively in parallel with the BCD counter, IC1.

The 5-bit D-A converter uses the four bits from binary counter IC3 plus the output from flipflop IC4a as the least significant bit. The resulting 5 bits are converted to a voltage to be presented to the speed comparator.

Since we have two counters operating in parallel, there must be safeguards to ensure that the both have the same value at any time. In other words both counters must track and count up or down together.

To do this, the counters are both preloaded to a "3" at power up. If counter IC3 is taken beyond its 15 count (155km/h on the display), the carry out signal returns both counters to "3" at the preload input via the over/under range detect block. If the counters are taken to below "0", the under range detect section is triggered via the borrow output of IC3 and the counters are again preloaded to a "3".

Hence, when the Speed Alarm is first turned on, 30km/h is the initial speed setting.

Main Features

- Overspeed indication range from 0-155km/h
- Speed settings in 5km/h increments
- Audible and visual overspeed alarms
- Visual alarm stays on during overspeed
- Audible alarm sounds every 10 seconds during overspeed
- 3-digit LED display
- Display dims when headlights are on
- Illuminated Up and Down speed set switches
- Single trimpot speed calibration

Circuit description

Fig.3 shows the circuit diagram for the Speed Alarm. It uses 11 low-cost ICs and three 7-segment displays plus several transistors, diodes, resistors and capacitors.

IC1 is the 74HC192 BCD counter driving the 4511 7-segment decoder driver, IC2. IC2 drives the 7-segment LED display, DISP2. We have added a little refinement to the decoder to improve the display of digits 6 and 9. This adds the "d" segment when the "9" is displayed and the "a" segment for the "6". This is achieved as follows.

When "6" is displayed, the "d" segment output is high and this also drives the "a" segment via D12. Diode D13 is there to prevent D12 driving the low "a" output at pin 13. Note that the "d" segment is lit for the "0", "2", "3", "5" and "8" counts as well but in this case the "a" segment is also lit and so the additional drive circuit does not affect other numbers.

When "9" is displayed, the D input at pin 6 of IC2 is high (it is low for counts from 0-7). This high drives transistor Q5 and its emitter drives the "d" segment of the display. Note that the D (most significant bit) input is also high for a count of "8" but since the "a" and "d" segments are also lit it does not matter that Q5 also drives the "d" segment. Diode D11 prevents the low "d" output at pin 10 being driven high via Q5 when displaying "9".

LED display DISP1 is driven via transistors Q6 or Q7. The a, c, d and f segments are hard wired via 270Ω resistors to the 5V supply. These segments are lit for both "0" and "5". PNP transistor Q6 is switched on when the Q output of flipflop IC4a is low and this drives the "g" segment when displaying "5". When the Q output of IC4a is high, IC5c's output is low and this drives Q7 and so the "b" and "e" segments are lit to display "0".

IC4a is a flipflop which is connected as a divide-by-two counter with its D input connected to the Q-bar output. On each positive edge of the clock input, the Q and Q-bar outputs toggle from a high to a low or vice versa. The clock signal to IC4a comes via diodes D1 or D2 from Schmitt trigger inverters IC5b & and IC5a which are wired as switch debouncers for the Up and

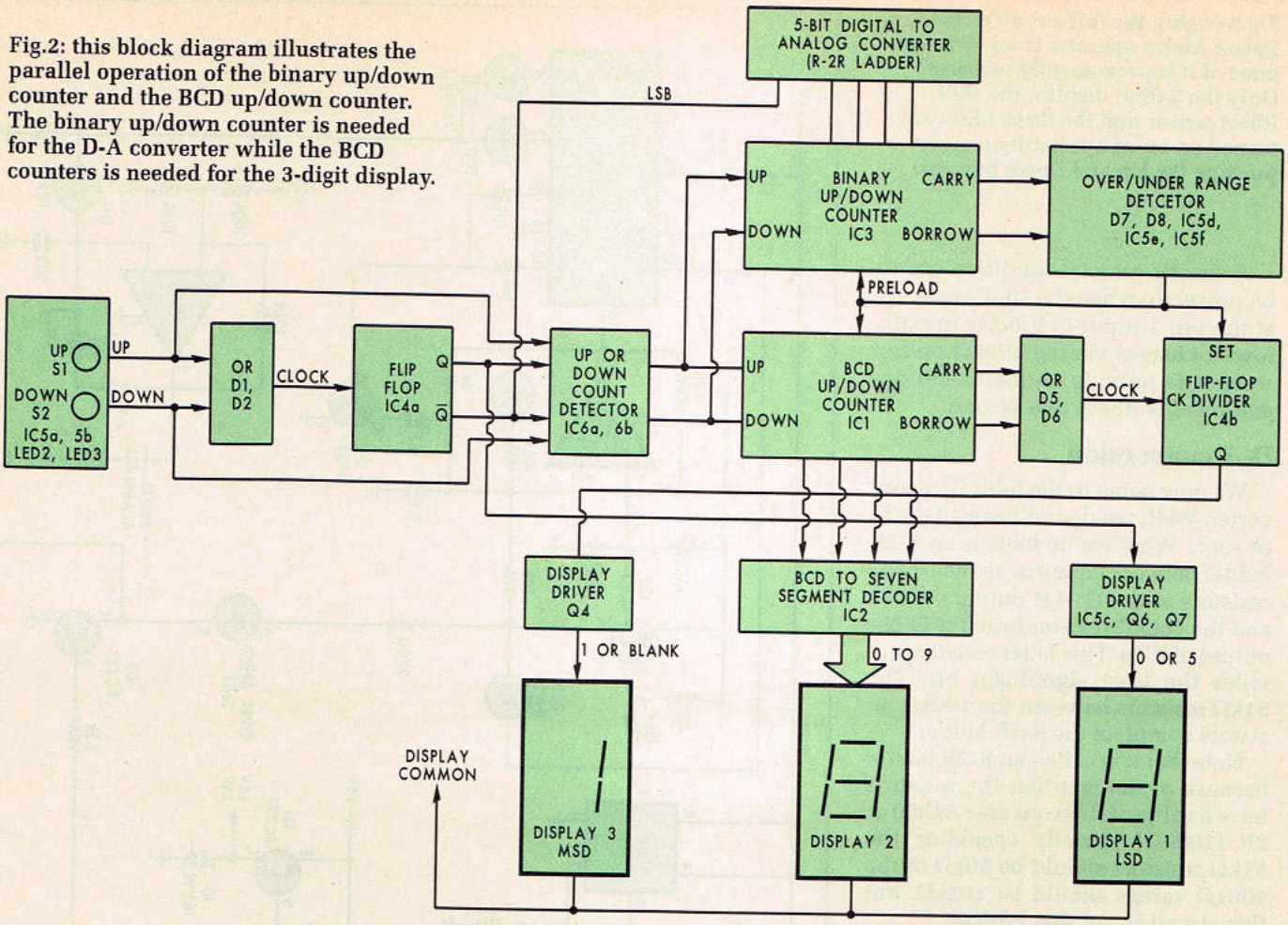


Fig.2: this block diagram illustrates the parallel operation of the binary up/down counter and the BCD up/down counter. The binary up/down counter is needed for the D-A converter while the BCD counters is needed for the 3-digit display.

Down buttons. So whichever button is pressed, IC4a is clocked. So the circuit so far has no way of knowing which button was pressed.

Up/Down detection

The outputs of IC5a and IC5b connect to NAND gates IC6a and IC6b respectively, at their pin 2 and pin 6 inputs. Meanwhile, the Q and Q-bar outputs of IC4a connect to pin 1 of IC6a and pin 5 input of IC6b, via 0.1µF capacitors. So IC6a detects when the Up button is pushed and IC6b detects when the Down button is pushed.

If the Q output of IC4a was high when the Up switch was pressed, corresponding to "0" being displayed by DISP1, then the resulting low Q output upon clocking would prevent IC6a's output going low. Thus no up counting will occur. This allows IC4a to produce a "5" on DISP1 without DISP2 changing. DISP2 will only change to the next up count when the "5" displayed on DISP1 goes to a "0".

When the Down switch is pressed, the opposite sequence happens compared to the Up count. The difference is that the down count only occurs when DISP1 goes from "0" to "5" (when IC4a's Q-bar output goes from low to high).

Borrow & carry

Our circuit for the BCD up/down counter IC1 and the binary counter IC3 is a little unusual in that we are using both the "Borrow" and "Carry" outputs. These terms Borrow and Carry may seem at little confusing but they are quite straightforward. The term "Carry" comes from the familiar process of addition: when you add up a column of figures, you "carry" the sum over to the next column. Similarly, when you subtract one row of figures from another, you often have to "borrow" from the next column in order to do the operation.

In an up/down counter, the carry output goes low when the count goes over "9" when counting up and the borrow output goes low when counting down, below "0". We use the borrow and carry outputs of IC1 to determine whether the third digit, DISP3, displays "1" or is blanked.

The borrow and carry outputs of IC1 are coupled to the clock input of flipflop IC4b via diodes D5 and D6. When it is low, the Q output of IC4b drives PNP transistor Q4 to switch on the "b" and "c" segments of DISP3 to display a "1".

As noted above, binary counter IC3 tracks IC1. When IC3 counts up past "15" or down below "0", the carry or borrow outputs respectively will go low and produce a low on the load inputs of IC1 and IC3 via the two inverters IC5d and IC5e. The A and B preload inputs of IC1 and IC3 are tied high while the C and D preload inputs are tied low. This sets a count of "3" on both counters, IC1 & IC3.

At the same time, inverter IC5f feeds a high to the set input (S) of IC4b. This causes its Q output to go high and turn off transistor Q4 and this turns off DISP3.

Fig.3 (right): the full circuit of the Speed Alarm operates from +5V and most of it is permanently powered. Only the 3-digit display, the Hall Effect sensor and the three LEDs are turned on or off by simultaneously pushing the Up and Down buttons.

A similar preload condition occurs on power up when the 10µF capacitor at the pin 1 input to IC5d is initially low. It charges via the 100kΩ pullup resistor to provide normal count operation after about one second.

D-A conversion

We now come to the 5-bit D-A converter. Well, we do not have a D-A IC as such. What we do have is an R-2R ladder network comprising the 100kΩ resistors at the Q1-Q4 outputs of IC3 and the 100kΩ resistor from the Q-bar output of IC4a. This latter resistor provides the least significant bit. The 51kΩ resistors between the 100kΩ resistors complete the R-2R ladder.

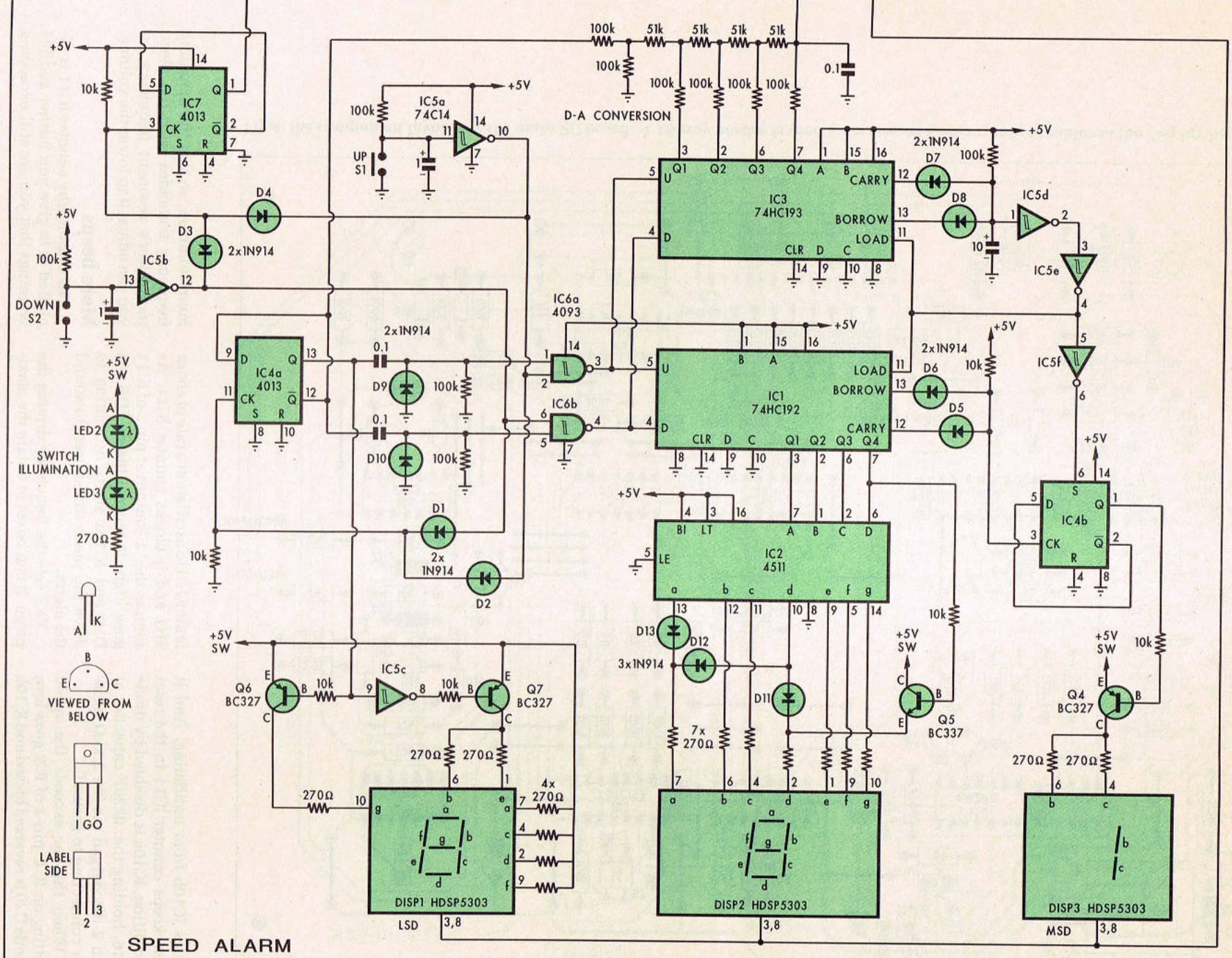
Note that it is called an R-2R ladder because of the fact that the resistors have a value of R (in our case 51kΩ) or 2R (100kΩ). Strictly speaking, the 51kΩ resistors should be 50kΩ or the 100kΩ values should be 102kΩ, but this circuit is not that critical.

The DC output from the ladder network connects to the comparator input at pin 10 of IC8, the LM2917 frequency-to-voltage converter. The front part of the LM2917 does the voltage to frequency conversion of the speed signal from the Hall Effect drive shaft pickup and its output is at pin 3 where it is filtered with a 6.8µF capacitor and then applied to the second comparator input at pin 4 via the 22kΩ resistor.

Pin 5 of IC8 is the comparator output. It is fed to IC9, a 555 timer IC which we are using simply as a Schmitt trigger inverter to give a fast risetime signal. IC9 drives transistor Q3 when its pin 3 output is low and this in turn lights the overspeed LED (LED1).

Audible alarm

The audible alarm comprises an LM358 dual op amp IC10 and a 4017 decade counter IC11. Both op amps are configured as Schmitt trigger oscillators. When pin 3 of IC9 is high, diode D20 holds the 0.1µF capacitor at pin 6 of IC10 high and therefore


SPEED ALARM
D-A CONVERSION
IC7 4013
IC5a 74C14
IC3 74HC193
IC1 74HC192
IC2 4511
IC4a 4013
IC4b
IC5b
IC5c
IC5d
IC5e
IC5f
IC6a 4093
IC6b
UP S1
DOWN S2
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
2x1N914
3x1N914
LED2
LED3
SWITCH ILLUMINATION
Q4 BC327
Q5 BC337
Q6 BC327
Q7 BC327
VIEWED FROM BELOW
I GO
LABEL SIDE
DISP1 HDSP5303
DISP2 HDSP5303
DISP3 HDSP5303
LSD
MSD
+5V
+5V SW
100k
51k
10k
270Ω
0.1

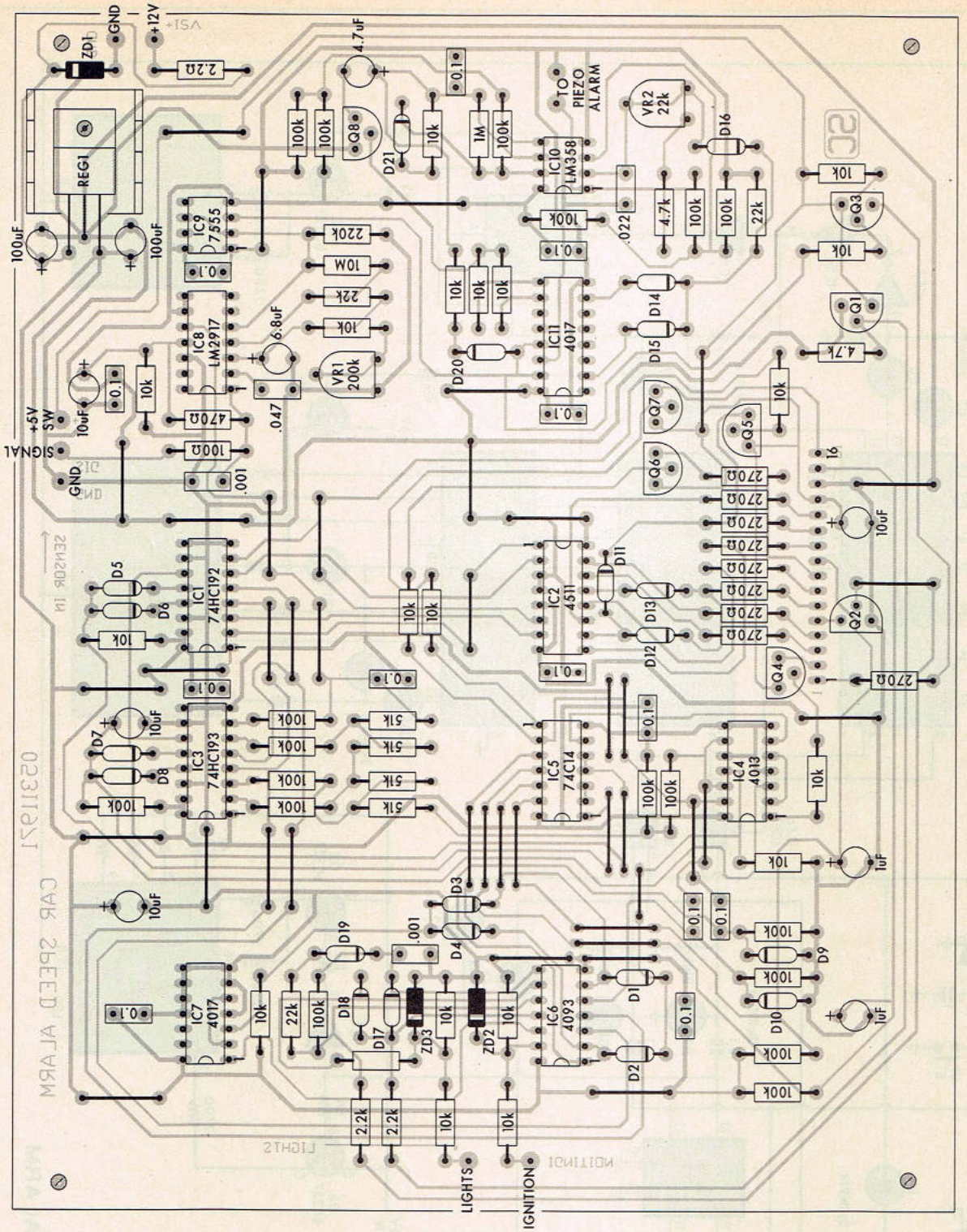


Fig.4: the component layout for the main PC board. A 16-way header is used to terminate 8-way rainbow cables to the display board.

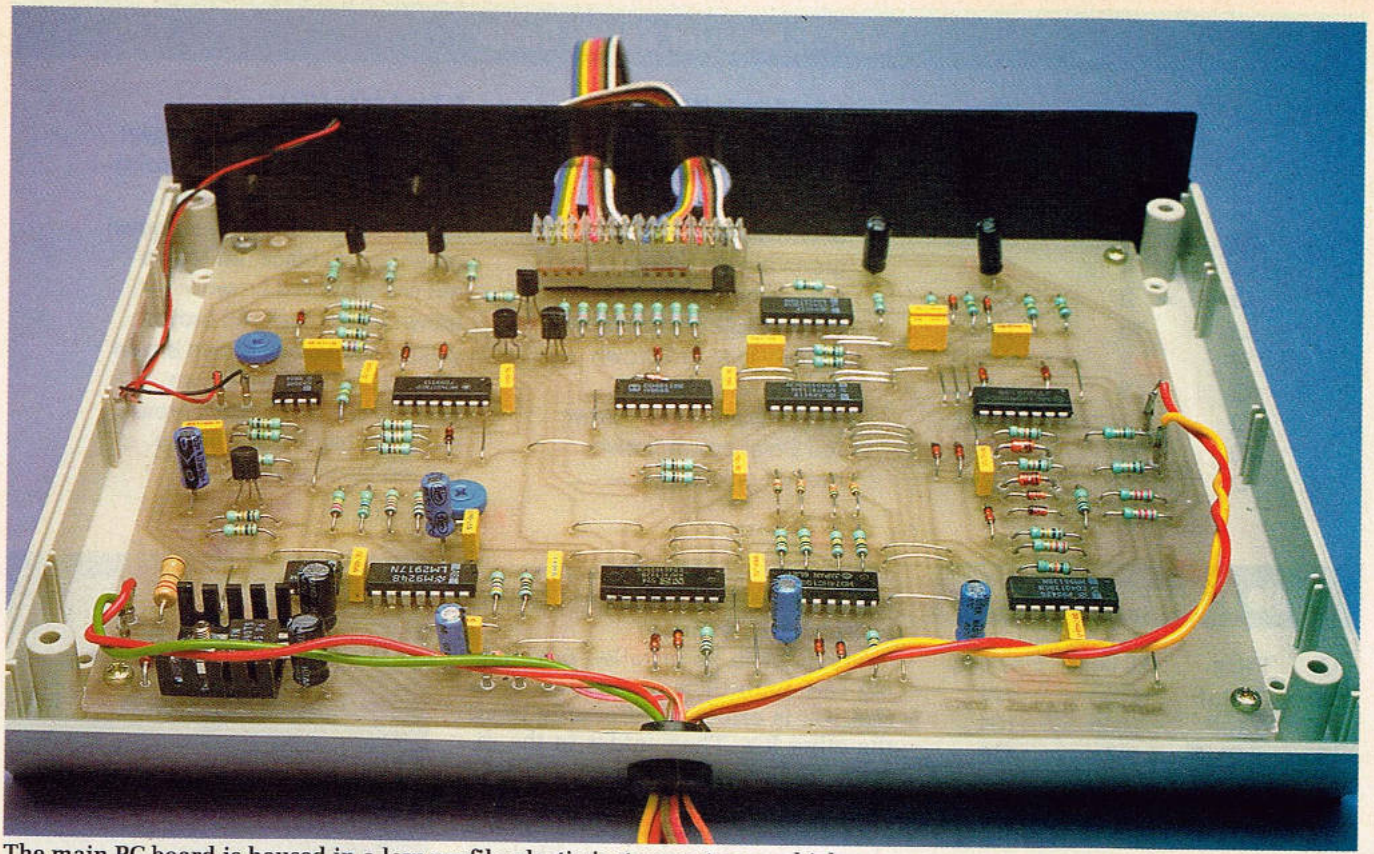
stops IC10b from oscillating. And it also keeps counter IC11 in the reset condition. IC10a is disabled by diode D16, holding the .022µF capacitor at pin 2 discharged via the 2.2kΩ resistor connecting to ground.

When the car exceeds the speed setting on IC1, pin 3 of IC9 goes low, diode D20 is reversed biased and IC10b is allowed to oscillate at a rate of about 2Hz and it clocks counter IC11. As soon as the "1" output at pin 2 of IC11 goes high, it reverse biases D16 via D15 and IC10a starts oscillating to drive the piezo transducer, to sound the alarm.

VR2 sets the frequency driving the piezo. It can be set to obtain the maximum loudness, so that the operating frequency coincides with the piezo transducer's resonant frequency; or you can adjust it to lower the volume.

More beeps

The reason why counter IC11 is included is to give you further audible warnings that you are still exceeding



The main PC board is housed in a low-profile plastic instrument case which can be mounted under the dashboard or if preferred, under one of the front seats. The connections to the display board are run via ribbon cable.

the set speed limit. This is necessary because you might have been distracted during a passing manoeuvre or other event. Hence, as IC10b continues to clock IC11, the "2" output goes high. IC10a now stops oscillating, with D16 holding the .022µF capacitor discharged. When IC11 is again clocked by IC10b, the "3" output goes high at pin 7 and allows IC10a to oscillate via diode D14. When IC11 is clocked again, IC10a stops as the "4" output goes high.

This high "4" output of IC11 drives transistor Q8 which turns on to connect a 4.7µF capacitor at pin 6 of IC10b, and this greatly slows the frequency of oscillation. When IC11 is clocked again several times the 4.7µF capacitor is again placed in circuit via the "8" output driving Q8. Finally, the "1" output of IC11 will go high again and allow oscillator IC10a to sound the piezo transducer again.

Thus, we have a "pip pip" sound from the alarm as the "1" and "3" outputs of IC11 successively go high and then a several second pause before sounding again.

The pin 3 output of IC9 goes high again, when the car's speed drops below the set limit, and this resets IC11 and disables IC10b.

Power for the circuit comes from the vehicle's 12V battery supply and is regulated to 5V with REG1. The 16V zener diode at REG1's input gives protection against voltage spikes or wrong supply connections. Note that the circuit is powered at all times but the display is blanked until the ignition is turned on or both buttons are pressed simultaneously to bring the Speed Alarm into operation.

The ignition input is monitored by NAND gate IC6c. It drives the base of Q1 and this transistor provides the 5V switched supply to the Hall sensor and LED2 & LED3. These LEDs light the Up & Down switches so they can be seen at night. Pin 9 of IC6d monitors whether the headlights are on. If they are off, pin 10 of IC6d turns Q2 on to provide the low common cathode voltage for the displays and overspeed LED (LED1).

If the lights are on, IC6d oscillates and turns Q2 on and off to dim the displays, for night time driving.

When the Up and Down switches are pressed simultaneously, IC5a & IC5b will both go low and diodes D3 & D4 are reverse biased. This causes the clock input to IC7 is to be pulled high via the associated 10kΩ resistor and toggles its Q output low. The resulting low on pin 12 of IC6c takes the pin 11 output high and Q1 is off. Diodes D17 and D18 pull both pin 8 and pin 9 of IC6d high and pin 10 is therefore low. Q2 is off and so the displays are unlit.

Pressing both Up & Down switches again will toggle the Q output of IC7 high again and so IC6c can go low, driving Q1. This low also reverse biases D17 and D18 and Q2 is on and so the display will be lit.

Note that pressing both the Up and Down buttons simultaneously may also change the counters depending on which switch makes contact first. So turning the speed alarm on and off may change the setting by 5km/h, meaning that the initial setting may be for example 35km/h instead of 30km/h.

Construction

The Speed Alarm is constructed on three PC boards. The main PC board is coded 05311971 and measures 198 x 155mm. The display PC board is coded 05311972 and measures 62 x 47mm,

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10MΩ	brown black blue brown	brown black black green brown
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	19	100kΩ	brown black yellow brown	brown black black orange brown
❑	4	51kΩ	green brown orange brown	green brown black red brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	18	10kΩ	brown black orange brown	brown black black red brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	18	270Ω	red violet brown brown	red violet black black brown
❑	1	2.2Ω	red red gold brown	red red black silver brown

Table 2: Capacitor Codes

❑	Value	IEC Code	EIA Code
❑	0.47µF	470n	474
❑	0.1µF	100n	104
❑	.047µF	47n	473
❑	.022µF	22n	223
❑	.001µF	1n	102

while the sensor PC board is coded 05311973 and measures 25 x 31mm. The main PC board is housed in a case measuring 225 x 40 x 165mm, while the display PC board is housed in a plastic utility case measuring 82 x 53 x 30mm.

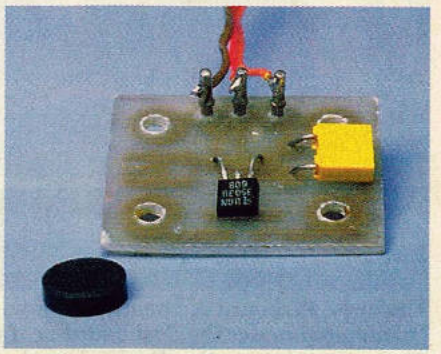
Before doing any assembly, check the PC boards for any breaks or shorts between tracks and undrilled holes. Make any repairs needed. Then start with the main board and solder in all the links as shown on the overlay diagram of Fig.4. Insert and solder in all the resistors using the accompanying resistor colour code table (Table 1) to select each value.

The ICs can be installed next, taking care with their orientation. Note that IC2 is oriented differently to all the other ICs. Then solder in the diodes, including the zeners, and take care with their orientation.

Insert the capacitors next. Table 2 shows the codes which are likely to be marked on the MKT polyester types. Take care to insert the electrolytic capacitors with the correct polarity.

The 3-terminal regulator REG1 mounts horizontally with its metal face towards the PC board and a small heatsink beneath it. Next, mount the spacers, transistors and trimpots. We used a 16-way pin header for the multiple connections required to the display PC board.

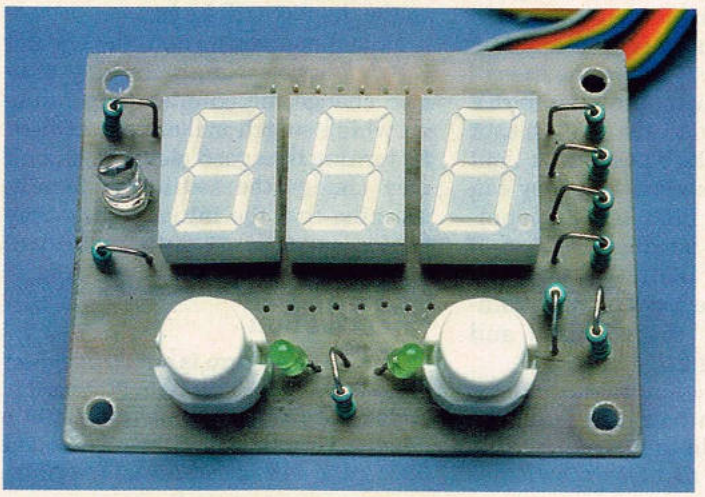
Fig.6 shows the component layout for the display PC board and sensor board. Before inserting any components into the display board, check



The completed sensor board and its companion button magnet.

that it fits neatly into the small case. You may need to do some judicious filing to make it a neat fit.

Insert the 7-segment displays with the decimal points towards the switches. All the resistors are mounted end-on as shown. LED1 is mounted hard against the PC board, while LEDs 2 and 3 need to lean over towards their respective switches. The two switches



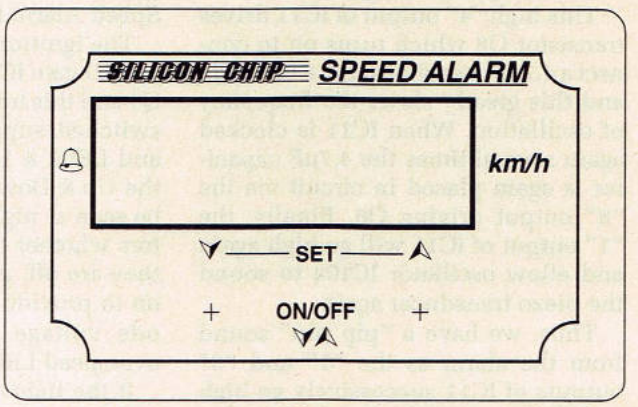


Fig.5 (above) shows the full-size artwork for the display case, while at left is the assembled display PC board. Note how the two green LEDs are arranged.

are oriented with their flat sides towards the bottom of the PC board, as shown in Fig.6. The two 8-way rainbow cables are soldered to the back of the board.

The sensor board is assembled as shown in Fig.6. The sensor and capacitor mount flat on the PC board, with the labelled side of the sensor facing up.

Case assembly

The main PC board can be placed in its case and secured with four self-tapping screws into the integral standoffs in the base. Drill out the rear panel for the cordgrip grommet. The front panel requires two holes for the rainbow cable entry and holes to mount the piezo transducer. This is secured with two self-tapping screws. Drill a small hole for the wires.

The display case is cut down to 23mm in height using a hacksaw and file. This allows the displays to sit directly under the red Perspex which replaces the front panel lid of the case.

Cut the Perspex to size and cut out the display area on the front panel label with a sharp hobby knife. Affix the label to the Perspex and drill holes for the switches and securing screws at each corner. You will need to cut a slot in the base of the case for the rainbow cable to exit.

Pass the rainbow cables through the slot in the case and clip the PC board in place. Secure the front panel in place with self-tappers. Pass the rainbow cables through the holes in the front panel of the main PC board case and attach the 16-way pin header socket to the wires. We used IDC (Insulation Displacement Connector) inline pin headers.

Testing

Apply 12V to the +12V and IGN inputs. The display should light. If not, press the two switches together to check that it turns on. If not check for supply on all the ICs. There should be +5V between pins 16 & 8 of IC1, IC2, IC3 and IC11, between pins 14 & 7 of IC4, IC5, IC6 & IC7, between pin 8 & 12 of IC8, pins 8 & 1 of IC9 and pins 4 & 8 of IC10.

Most of these ICs will have additional pins tied to the +5V rail, as can be seen on the circuit of Fig.3. These can also be checked with your multimeter, as can the IC pins which are tied to 0V.

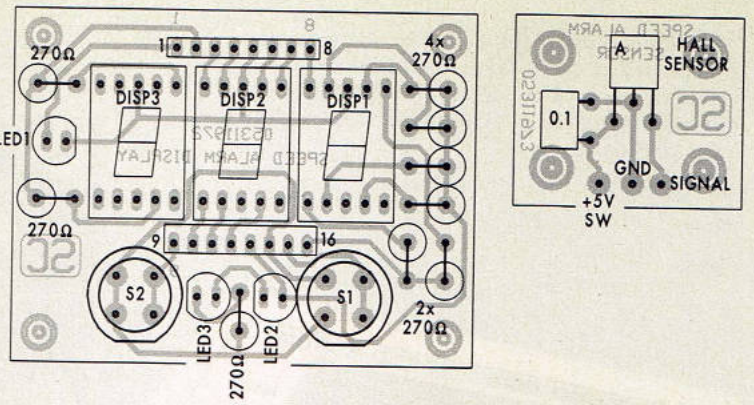


Fig.6: the component layouts for the display and Hall Effect sensor PC boards. Note that LEDs 2 & 3 lean towards their respective pushbutton switches.

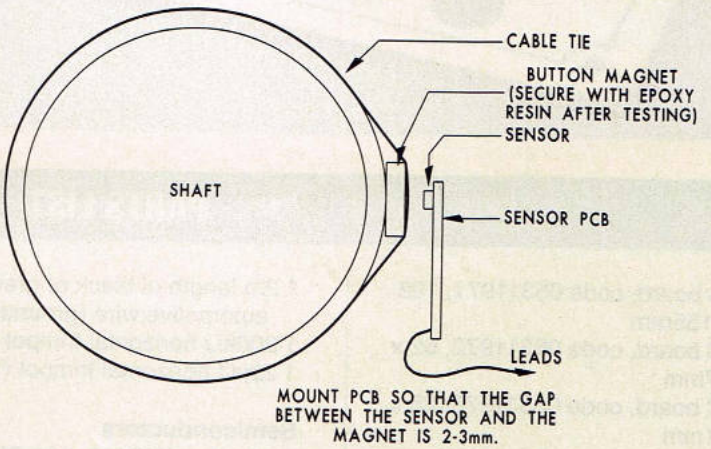

CABLE TIE
BUTTON MAGNET (SECURE WITH EPOXY RESIN AFTER TESTING)
SENSOR
SHAFT
SENSOR PCB
LEADS
MOUNT PCB SO THAT THE GAP BETWEEN THE SENSOR AND THE MAGNET IS 2-3mm.

Fig.7: the mounting details for the Hall Effect speed sensor. The gap between the sensor and the magnet should be 2-3mm.

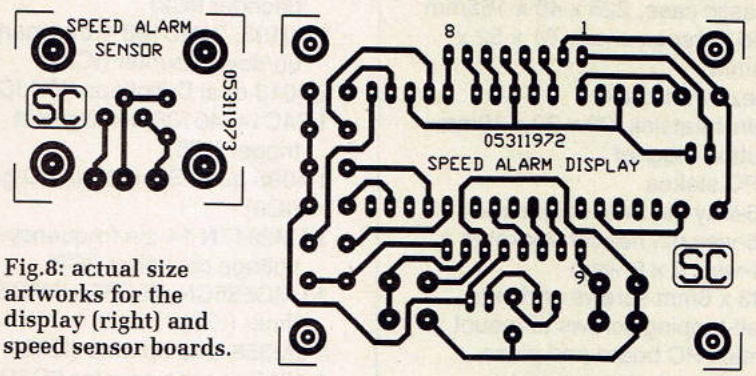


Fig.8: actual size artworks for the display (right) and speed sensor boards.

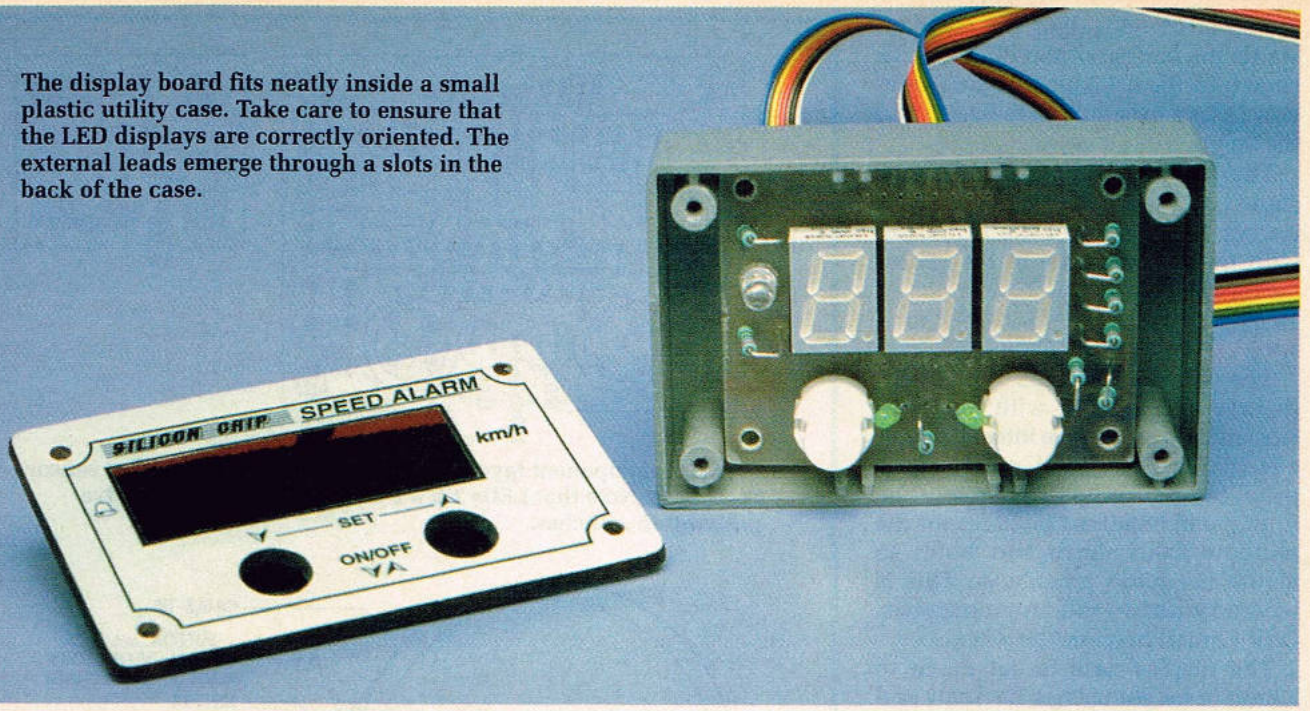
If the display is showing a reading, test the Up and Down switches. Now count down to 0 and check that LED1 lights and that the piezo alarm sounds.

You can test the dimming feature by applying 12V to the lights input.

Installation

The speed alarm can be installed into a vehicle using automotive connectors to make the connections to +12V, the ignition supply and lights. Use automotive wire for these connections. Also the ground connection can be made to the chassis with an eyelet and a self-tapping screw. Attach the main case under the dashboard on suitable brackets. Mount the

The display board fits neatly inside a small plastic utility case. Take care to ensure that the LED displays are correctly oriented. The external leads emerge through a slots in the back of the case.



PARTS LIST

1 PC board, code 05311971, 198 x 155mm
1 PC board, code 05311972, 62 x 47mm
1 PC board, code 05311973, 25 x 31mm
1 front panel label, 81 x 52mm
1 plastic case utility case, 82 x 53 x 30mm
1 plastic case, 225 x 40 x 165mm
1 red Perspex sheet, 81 x 52 x 3mm
1 piezo transducer
1 mini heatsink, 20 x 20 x 10mm
1 button magnet
12 PC stakes
1 16-way pin header launcher
1 16-way pin header socket (4 x 4-way, 2 x 8-way)
3 M3 x 6mm screws and nuts
6 self-tapping screws to mount main PC board and piezo
1 small cordgrip grommet
2 PC-mount click action push-on switches (white) (S1,S2)
1 800mm length of 0.8mm tinned copper wire
2 1m lengths of 8-way rainbow cable
3 2m lengths of hookup wire (+, GND and signal sensor wires)
3 2m lengths of red automotive wire (+12V, ign. & lights input)
1 2m length of black or green automotive wire (ground wire)
1 200kΩ horizontal trimpot (VR1)
1 22kΩ horizontal trimpot (VR2)

Semiconductors
1 40192, 74HC192 4-bit BCD up/down counter (IC1)
1 4511 BCD to 7-segment decoder (IC2)
1 40193, 74HC193 4-bit binary up/down counter (IC3)
2 4013 dual D flipflops (IC4,IC7)
1 74C14, 40106 hex Schmitt trigger (IC5)
1 4093 quad Schmitt NAND gate (IC6)
1 LM2917N 14-pin frequency-to-voltage converter (IC8)
1 LMC555CN, TLC555 CMOS timer (IC9)
1 LM358 dual op amp (IC10)
1 4017 decade counter (IC11)
1 7805, LM340T5 5V 1A 3-terminal regulator (REG1)
1 UGN3503 Hall Effect sensor (sensor1)
21 1N914, 1N4148 signal diodes (D1-D21)
1 16V 1W zener diode (ZD1)
2 4.7V 1W zener diodes (ZD2,3)
5 BC327 PNP transistors (Q1,Q3, Q4,Q6,Q7)
3 BC337 NPN transistors (Q2,Q5, Q8)
3 HDSP5303 common cathode 7-segment LED displays (DISP1-DISP3)
1 5mm high intensity red LED (LED1)
2 3mm red or green LEDs (LED2,LED3)

Capacitors
2 100µF 16VW PC electrolytic
4 10µF 16VW PC electrolytic
1 6.8µF 16VW PC electrolytic
1 4.7µF 16VW PC electrolytic
2 1µF 16VW PC electrolytic
13 0.1µF MKT polyester
1 .047µF MKT polyester
1 .022µF MKT polyester
2 .001µF MKT polyester

Resistors (0.25W, 1%)

1 10MΩ	18 10kΩ
1 1MΩ	2 4.7kΩ
1 220kΩ	3 2.2kΩ
19 100kΩ	1 470Ω
4 51kΩ	18 270Ω
2 22kΩ	1 2.2Ω 0.5W

Miscellaneous
Automotive connectors, bracket for sensor board, heatshrink tubing, etc.

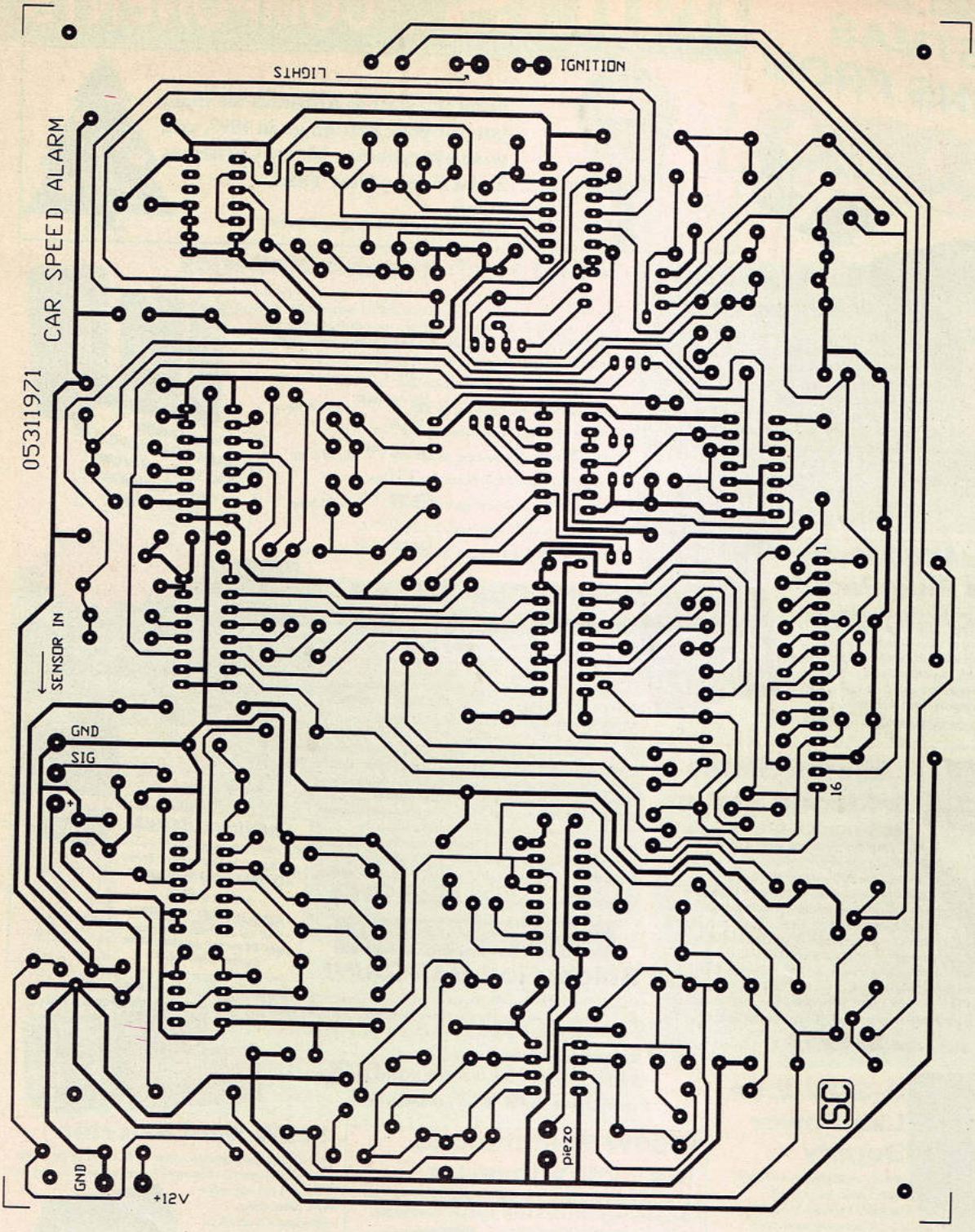


Fig.9: actual size artwork for the main PC board. Check your board carefully against this artwork for possible etching defects before installing any of the parts.

display in a convenient place on the dashboard.

The sensor board should be sheathed in a piece of heatshrink sleeving and then mounted near the drive shaft as shown in Fig.7. Temporarily mount the button magnet in place with a cable tie and secure the board so that the magnet will directly pass the sensor with a 2-3mm gap. Wire the sensor to the main PC board using hookup wire.

Test that the speed alarm works at a low speed setting. You may need to adjust VR1 slightly so that it works at the correct speed. It is calibrated so that the alarm sounds near the set speed, as indicated on the speedometer. If nothing happens, remove the magnet and turn it around so that the opposite pole is facing out and test again. If the speed alarm cannot be made to work at any speed, the magnet may not be powerful enough or the gap between sensor and magnet is too great.

When the speed alarm is operating satisfactorily, use epoxy resin to permanently secure the magnet to the drive shaft. **SC**

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ALTRONICS

CHRISTMAS BARGAINS FROM ALTRONICS

To All Our Valued Customers

From the staff at Altronics we thank you for your patronage in 1997, and wish everybody a Merry Christmas and a Happy New Year!

Regards,
Jack O'Donnell, Managing Director

Battery Charger & Refresher

Keep your rechargeables in top condition and extend their service life! Also Includes Alkaline Refresh Function.

Charges or discharges Nickel Cadmium and Nickel Metal-Hydride cells, and refreshes up to four carbon or alkaline cells, or up to two 3V lithium cells. Accepts AA and AAA sizes of all capacities. Features LED charging status and cell type indicators. Discharger operates at the push of a button, and if used to "cycle" batteries regularly, it can reduce memory effect in rechargeable cells, giving longer service life. Powered by 12V DC, either from M 9664 plug pack (not included) or car battery.

A 0280 **$39.95**
M 9106 12V 500mA Plug Pack **$22.95**

NiCad Rechargeable Batteries

With Christmas coming up, chances are you'll be paying out for batteries to power the presents! These NiCad rechargeable cells will eventually pay for themselves, and can provide hundreds of recharges if cycled periodically (see our A 0280). They can be used in just about any battery powered appliance.

S 4705 700mAh AA Cell Normally $2.30 ea,
NOW **$2** ea, 4 and up, or **$1.60** ea, 10 & up

S 4710 1500mAh C Cell Normally $4.95 ea,
NOW **$4** ea, 4 and up, or **$3.50** ea, 10 & up

S 4715 1500mAh D Cell Normally $5.25 ea,
NOW **$4** ea, 4 and up, or **$3.75** ea, 10 & up

S 4720 100mAh 9V Cell Normally $10.95 ea,
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High Quality MINAMOTO brand! Get up to 1000 recharges or more! Australia's LOWEST prices!

REGULATED Multi-Voltage Plug Pack

Internal regulator provides precise voltage output and smooth DC for sensitive devices!

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M 9516 Normally $28.95, NOW **$19.95**

20MHz Dual Trace 4 Beam Oscilloscope

BONUS FREE MULTIMETER!

Highly recommended for the service bench, labs, universities and the dedicated enthusiast.

Electronic circuits are becoming more and more complex as technology advances, to the point where it is difficult to service and repair many electronic products without the aid of an oscilloscope. The Q 0150 oscilloscope is a very stylish, modern and high tech piece of test equipment that will enable you to test and service a wide range of equipment. The front panel controls have been thoughtfully laid out making it extremely easy to use. One standout feature of this CRO is the ALT.MAG function which allows simultaneous display of both original and magnified waveforms on the screen. This function allows the user to observe trigger pulses & modulated signals, and to identify signal anomalies such as supersonic oscillations & EMF spikes.

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Comes complete with TWO high quality 80MHz CRO Probes, valued at $39.95 each!!

Features Simultaneous display of original and magnified waveforms, both traces shown.

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WOW! With every Q 0150 CRO purchased in December, receive a **Q 1060 Digital Multimeter**, valued at **$89**

ABSOLUTELY FREE!!

See our 1997/98 Catalogue page 98 for full details on this superb instrument!

Amazing Special! A Professional Soldering Station for Under $100!

Micron Series 3 Soldering Station

The *MICRON* Series 3 soldering station employs electronic switch mode circuitry in lieu of a mains transformer. Excellent for all general purpose and production soldering. **Features:** • High insulation ceramic heating element • Rapid heat-up and heat recovery • Heater insulation of over 100MΩ • Zero voltage circuit minimises high voltage spikes & magnetic fields to prevent damage to sensitive devices • Continuous temperature adjustable from 250° to 430°C • Grounded power cord • Selecting the desired operating temperature is as simple as turning a knob. ***Supplied with Long-Lasting Iron Clad Tip!***

T 2443 Normally $129, NOW **$99**

Solder Roll *BARGAIN!*

OOPS! This solder is a 40/60 mix of tin/lead, instead of the regular 60/40. We've tested it, and it solders just fine! Stock up at fantastic rates and keep some handy in the workshop! *Available in 0.8mm or 1mmØ sizes.*

T 1100A 0.8mm Was $6.50 a Roll
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What a Super Deal! Stock up on solder at a bargain price!

0-30V 2.5A Lab Power Supply

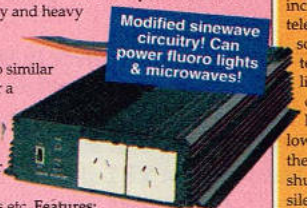
Precision Digital LCD Volt and Current meters accurate to within 0.5%!

A fully built lab power supply with a main output rail adjustable between 0 and 30V, at up to 2.5A. Separate controls for voltage and current limiting. Features Digital LCD Voltage and Current Meters enabling precise adjustment of the power supply for use in research and development labs, instrumentation testing, digital circuits, etc. Also features fixed 12 Volt and 5 Volt output rails, at up to 1 Amp peak.

M 8200 Normally $199,
NOW ONLY **$179**

For December only, we'll throw in a FREE set of Banana-to-Croc leads with every M 8200!

1500W Switchmode 12V / 240V Inverter



Modified sinewave circuitry! Can power fluoro lights & microwaves!

This inverter provides up to a massive *1500W* of 240V power from a heavy duty 12VDC car or truck battery. Switchmode circuitry eliminates bulky and heavy output transformers, making this unit very lightweight compared to similar inverters. It's suitable for a wide range of applications such as remote homes, sail & power boats, building or mine sites, off road vehicles, caravans, farms etc. **Features:**

• Over temperature & overload shutdown • **Auto fan cooling**
• Low battery warning & shutdown • **Heavy duty leads**
• Twin outlets • Weighs only 3.6kgs

M 8140 Normally $995, NOW **$795**

125W Mini Inverter

This amazing inverter provides up to 125W of 240V AC power from your car cigarette lighter socket! During our testing, it ran our entire A/V room setup, including a huge 68cm television and surround sound amp! Can power televisions, VCR's, lights, small battery chargers, shavers and hi-fi systems. Features low battery indicator, thermal & overload shutdown and is totally silent when operating. Built-in 3-pin plug (no adaptor required). Includes car cigarette lighter socket lead.

"There are quite a few different 12V to 240V inverters on the market, but few are as compact and as neatly packaged as this one" Silicon Chip, April '97

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Keychain Laser Pointer

This laser pointer weighs only 45g, and comes with a keychain. At only 61mm long by 14mm in diameter, it's not much bigger than many keys! It emits a very intense beam that can travel up to 50m, and projects a bright red dot onto the target is it aimed at. It's ideal for lectures, guided tours, seminars, building sites etc, and it's much less intrusive than a normal stick pointer! Uses two button batteries (included).

Great for tours, lectures, seminars etc!

A 0201 WAS $69, NOW **$49**

Hi-Power Siren

Strong & durable construction, makes this siren ideal for car, boat or home installation. Includes a handy bracket for surface mounting. **Extremely loud 120dB output.** Requires 12V DC @ 300mA. Dimensions 100Ø x 125L mm.

HUGE 120dB Output! Great for car & house security systems or alarm panels!

S 6130 Was $30.95, NOW **$20**

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BONUS ACCESSORIES!

Tip temperature is adjustable from 250°C to 450°C. Select the right temperature for the job and avoid heat damage to sensitive devices! Features ceramic heating element and supplied with 1.6mm conical tip. 3 other tip sizes available. **See 1997/98 Catalogue page 111.**

T 2446 **$49**

BONUS DEAL! While stocks last, get a T 1100A 200g solder roll, a T 1310 Iron stand *AND* a T 1450 PCB Stand, together valued at **over $30**, ***FREE*** with every T 2446!

Audio Masker Kit

(See EA Dec '97) An audio masker is a form of white noise generator. It's used to mask the noises heard by people suffering from tinnitus. Tinnitus is a common problem that can manifest its self in many ways , from a low level roaring to a constant ringing in the ear. This device "masks" these sounds by emitting a continuous noise (such as that of a rushing waterfall), which the brain can isolate more easily. It's much cheaper than commercially available units (some run to $800 each). It features adjustable level and degree of noise filtering. Powered from a 9V battery (not supplied), and comes complete with a silk screened case.

Relieve the irritating symptoms of tinnitus with this simple audio masker!

K 1260 **$21.95** NEW!

Crimp Tool & *FREE Strippers!!*

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This professional quality crimp tool is a fantastic addition to your technical tool kit. With proper care, it will virtually last a lifetime! *While stocks last, buy the T 1552 Pro Crimp Tool, and receive a set of T 1522 automatic wire strippers, valued at $22.95, FREE!* A perfect combination for alarm installers, car audio techs, auto electricians etc! Crimp tool suits red, blue and yellow size connectors. Ratchet action and all metal construction.

T 1552 Plus T 1522 ONLY **$54**

Learning Remote Control

with Backlit Screen

Can replace up to EIGHT remote controls. Get rid of your coffee table clutter!

Sick of having remote controls all over the coffee table? Always picking up the wrong one? This *learning* remote control can replace up to eight remotes! It features a multi-function *touch sensitive backlit LCD* screen. With 8 different appliance modes, it can control a TV, VCR, CD, LD, AMP, TAPE/TUNER, and has auxiliary modes SEL1 and SEL2, which can be custom configured. When you select a mode, the unit changes the buttons on the display to mirror the controls of the selected device. AMP mode includes Surround Sound effects adjustment button (centre, rear, surround etc). The unit is programmed from an original remote, which must be in working order, and a macro function allows one button to perform up to ten sequential tasks. Also features backlighting (unlike others on the market) which is essential at night or when the curtains are drawn. The backlighting is light sensitive, so it only activates in rooms with low light levels, saving batteries. Requires 4 x AAA batteries (supplied). *BEWARE OF NON-BACKLIT VERSIONS WHICH ARE USELESS IN DARK ROOMS!!*

"For anyone who wants the ultimate remote control, this has to be the one." Product Showcase, Silicon Chip Magazine May '97

BE QUICK! 50 ONLY!

A 1000 Normally $199, *XMAS SPECIAL only* **$169**

5 Digit Tacho Kit

At last! A useful digital tacho with super-fast update time and 1 rpm resolution!

(See EA Oct '97) A great high-tech addition to your car's dashboard! This 5 digit tachometer features a crystal timebase for super-accurate readings, a 0.25 second update time and a resolution of ONE rpm. It also has a dimmable display, leading zero blanking, last digit "0" lock (stops "rolling" display), and can read to 60,000rpm if required. Not even rotaries rev *that* high! Can be configured for ignition coil input (3V) or low level input (1V) from an existing tacho. If you're after a *useable* digital tacho for street or circuit applications, this is it! *Note: Case NOT included.*

K 4325 **$79**

Speed Alarm Kit

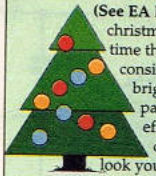
NEW!

(See SC Dec '97) *The best way to reduce the number of speeding fines you receive each year is to simply avoid speeding!* This kit lets you know when you're speeding by emitting an alarm and flashing an LED located on the dashboard of your car. The alarm point is adjustable in increments of 5 kph from 0 to 155 kph. You'll know you are speeding without taking your eyes off the road for a second. It consists of two sections, a dash mounted control panel which features a 3 digit display to indicate set speed, and a main box (not shown) housing most of the circuitry, which can be located under a seat or dashboard. A single trimpot is used to calibrate the unit to your existing speedometer. Kit comes complete with screened & punched cases and magnetic speed pickup, and is powered by 12V DC.

Save $$$ in speeding fines and possibly your license with this audible and visual overspeed alarm!

K 4390 **$72**

Santa's Christmas Lights Kit



(See EA Dec '97) Are you sick of those collections of christmas lights blowing globes every time they are used? This project consists of five strings of six super bright LED's that flash in a random pattern for a great christmasy effect! This project allows you to customise the flash rate to get the look you want. It's inexpensive, simple to construct, and adding more lights to the circuit is very simple. Comes complete with LEDs and silk screened case. Powered from a 12V AC 500mA plug pack, so it's safe around children.

Spruce up your Christmas tree with these inexpensive but super effective lights!

K 1150 **$24.95**

M 9666 12V AC 500mA Plugpack **$14.50**

NEW!

Video Enhancer & Stabiliser Kit

Archive those precious home video memories in top condition!

(See EA, Nov '97) Ever transferred your home or holiday movies to VHS and found the picture quality is degraded? This little enhancer will spruce up the video signal, and can even improve the quality of poorly-recorded video. It also has an image stabiliser which removes all the invisible overheads from video signals, such as teletext data, leaving a clean PAL composite signal. *If you're into making your own movies or taking some holiday footage, this is a very useful accessory!*

K 5830 **$59**

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AMERICAN EXPRESS Cards Welcome — Diners Club International — We welcome ... bankcard — MasterCard — VISA

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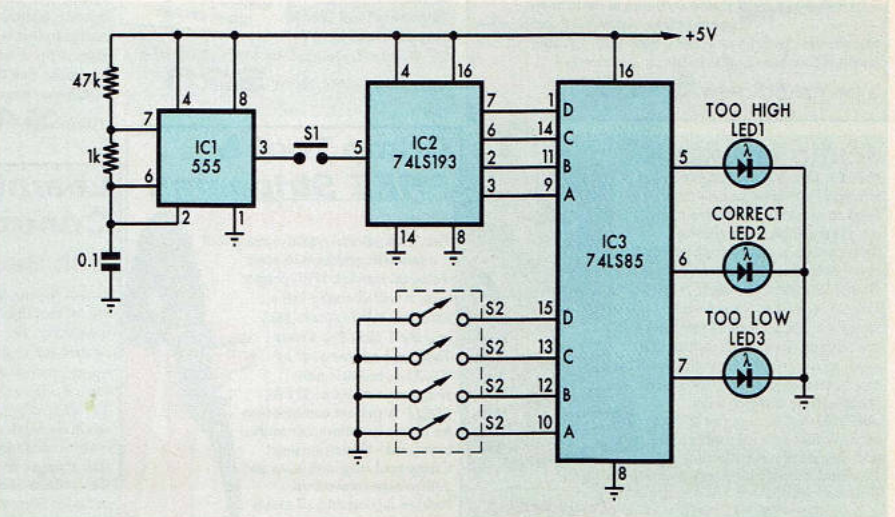
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Binary guessing game



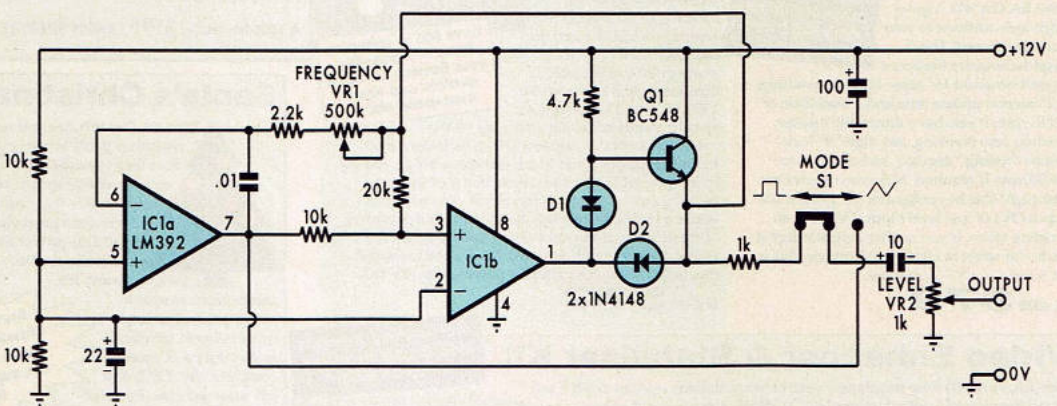
This circuit makes use of a 74LS85 4-bit magnitude comparator (IC3). As its name suggests it compares two 4-bit binary numbers at is inputs and produces one of three outputs depending on whether binary number A is larger than, equal to or less than number B. One of the 4-bit numbers is produced by a set of four switches which pull the relevant inputs of IC3 low. The other 4-bit number is produced by the 74LS193 synchronous up/down counter which is clocked by 555 timer IC1, each time switch S1 is pressed.

The object of the game is press switch S1 to load in the unknown number and then you or another player operate the four switches to guess the number. The LEDs indicate when you are high, low or correct.

While the circuit shows a supply voltage of 5V you could operate it from a 6V battery provided a diode is connected in series to reduce the voltage.

P. Melmoth,
Wyalong, NSW. ($30)

Waveform generator



This circuit is presented as an alternative to the waveform generator featured in the July 1997 issue of SILICON CHIP. This alternative circuit has the advantage of a square wave output with 1:1 mark/space ratio (50% duty cycle).

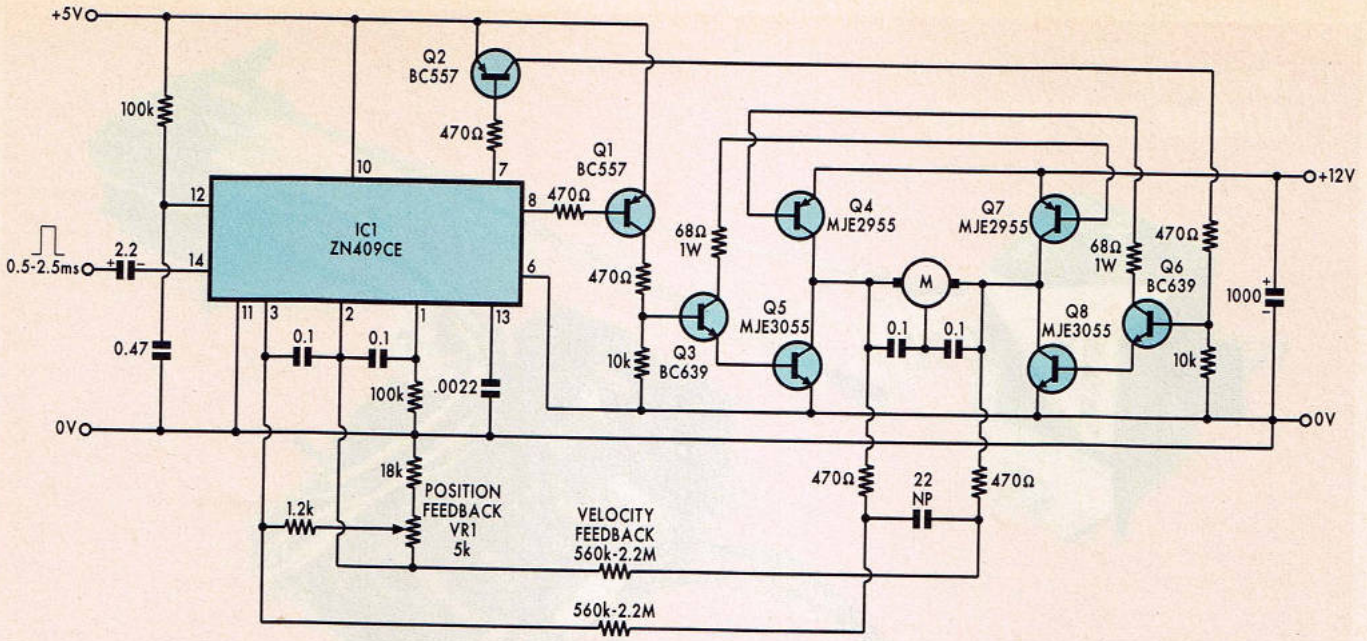
IC1 is an LM392, a dual device comprising one operational amplifier and one comparator. The transistor and its associated components provide an active pull-up for the comparator which has an open-collector output stage.

A voltage divider consisting of two 10kΩ resistors biases the op amp and comparator to half the supply voltage and controls the mark/space ratio. The supply voltage is not critical but must be stable as it determines the output amplitude.

In operation, comparator IC1a, which exhibits a large hysteresis due to positive feedback via the 20kΩ resistor, generates a square wave. This drives op amp IC1b, which is connected as an integrator. The integrator output is a highly linear triangular wave, the amplitude of which is monitored by the comparator.

A 12V supply results in a square wave of about 10.6V peak-to-peak at the emitter of the transistor. The 1kΩ resistor connected to the switch attenuates the square wave output to match the peak-to-peak voltage (typically 5.3V) of the triangular waveform.

A. Ellis, Porirua,
NZ. ($35)



Monster servo uses a windscreen wiper motor

While radio control servos are readily available from hobby stores, really powerful units are difficult to obtain or very expensive. This circuit turns an ordinary windscreen wiper motor into a powerful servo for the cost of a ZN409CE servo IC, six transistors and a few other components.

The ZN409CE and its input is compatible with typical radio control receivers and can run from their battery supply. The circuit values have been chosen to suit typical input pulse widths of 0.5-2.5ms, with positive-going pulses.

Q1, Q2, Q3 & Q6 provide level shifting so that IC1's output can drive a transistor bridge (Q4, Q5, Q7 & Q8) operating from a high supply voltage; ie, 12V. Depending on the input pulse width, the transistor bridge drives the motor in one direction or the other.

VR1 is the positional feedback pot and it must be coupled to the output shaft of the windscreen wiper motor. The positional accuracy of the servo is very dependent on the backlash in the mechanics of the system. If there is too much backlash, the servo will be slow and erratic.

Two electrical parameters affect the stability and accuracy of the servo: dead-band and velocity feedback. Dead-band is the allowable position deviation before the amplifier tries to make a correction. If there is more mechanical backlash than dead-band, the motor will chatter. The capacitor at pin 13 sets the dead-band; more capacitance gives more dead-band.

Setting up the system requires the following steps:

(1) Disconnect the shaft of the feedback pot from the motor and connect the circuit to a receiver. Power the system up. The motor should operate one way or the other.

(2) Rotate the feedback pot in the same direction as the motor would have turned it. The motor should come to rest and then run in the opposite direction. If this doesn't happen, swap the outer leads to the pot and try again.

(3) Connect the feedback pot to the motor shaft and power up again. The motor should move to a position and stop but will probably hunt back and forth. Try reducing the velocity feedback resistors until the system is stable. The motor shaft should move each time the transmitter stick is moved.

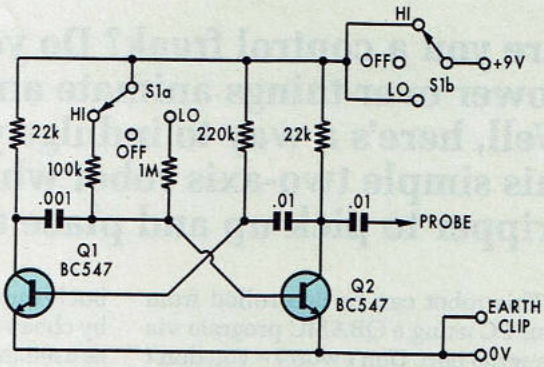
If the motor tends to buzz, you have more mechanical slack then dead-band and the capacitor at pin 13 should be increased. On the other hand, if the servo is stable but you have too much dead stick, you have too much dead-band or too much velocity feedback.

The ZN409CE IC is available from RS Components (Cat 304-813).

Nicholas Baroni,
Greensborough, Vic. ($45)

Audio signal injector

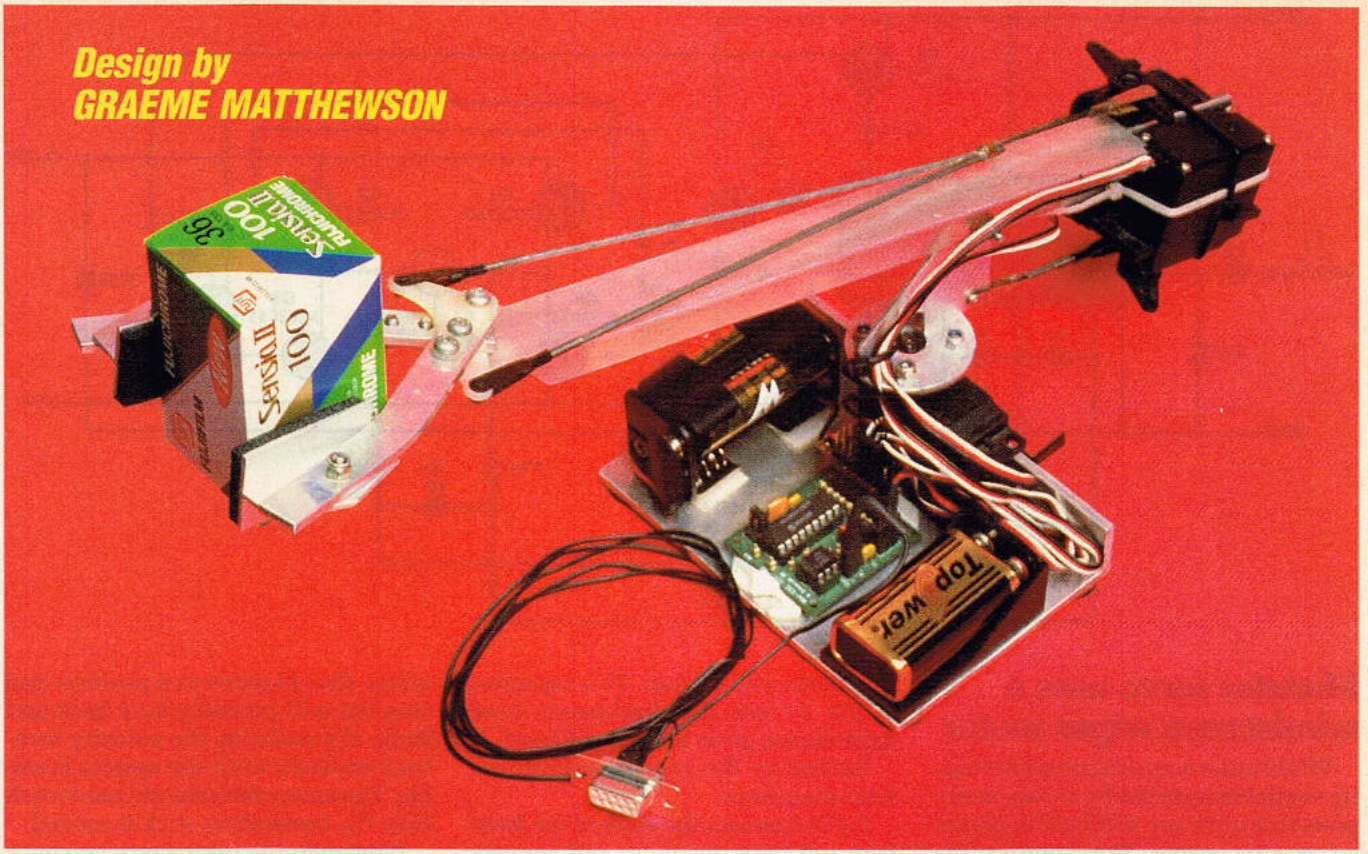
This injector was built as an adjunct to the Audio/RF signal tracer featured in the June 1997 issue of SILICON CHIP.



The circuit is basically a free-running multivibrator with the frequency determined by the supply voltage and the resistors and capacitors connected to the bases of the transistors. The switch allows it to run at two separate frequencies. It was constructed on a piece of Veroboard about 20mm square and mounted inside a film canister on top of a 9V battery.

R. Graham,
Nelson, NZ. ($20)

Design by
GRAEME MATTHEWSON



A 2-axis robot with gripper

Are you a control freak? Do you wish to exert power over things animate and inanimate? Well, here's a way to indulge yourself. Build this simple two-axis robot which has a gripper to pick up and place objects.

This robot can be controlled from your PC using a QBASIC program via the serial port. Don't worry – you don't have to know anything about programming in BASIC to make it work. Just go to the DOS prompt, type QBASIC and run the program which is called Ausbot.bas.

Apart from the simple method of control, a major attraction of this robot is the motive power. It is provided by cheap and readily available servos, as used in radio controlled model cars, boats and aircraft. These can be purchased from model stores everywhere or you might have some servos from model cars lying around – these will do just as well.

The servos provide the two axes of operation for the robot arm; ie, up & down or sideways motion and also open and shut the gripper. So just three servos are required.

As the title of this article suggests, this is a 2-axis robot with a gripper. It can rotate on its base through 90 degrees with extremely small movements: 254 steps of 0.354 degrees. It can raise and lower its arm from desktop level in 254 x 0.807mm steps to a height of 205mm. Similarly, it can open its gripper to 105mm wide or fully close it in 254 steps of 0.413mm.

With this sort of resolution this robot can pick up an egg without breaking it! Its fingertips can be made to pivot slightly so as to grasp irregular shaped objects or they can be tightened to grasp small items at their tips.

The Ausbot software takes care of speed control and only allows you to set speeds within safe limits for the robot. The required speed limits for each servo are different as each one controls items of different length and weight.

If the speed ranges allowed by the software are too fast or too slow, the upper and lower limits may need to be changed due to varying clock speeds of different computers. The software is easily understood and the user should have no difficulty in identifying the delay lines for each servo.

As described in the "Radio Control" column in last month's issue, a servo is basically a closed loop system, you just tell it where to go and it goes there; no argument. It will operate from between 4V and 6V DC and requires pulses of between 1ms and 2ms, at a rate of about 50Hz.

Also as described last month, 1.5ms wide pulses will rotate the servo shaft to it its "neutral" or null position; ie, more or less its central position. Furthermore, pulses 1ms wide will rotate it to the fully anticlockwise position while 2ms pulses will rotate it fully clockwise.

And since a servo is a closed loop system, it has a very large number of positions in between those extremes,

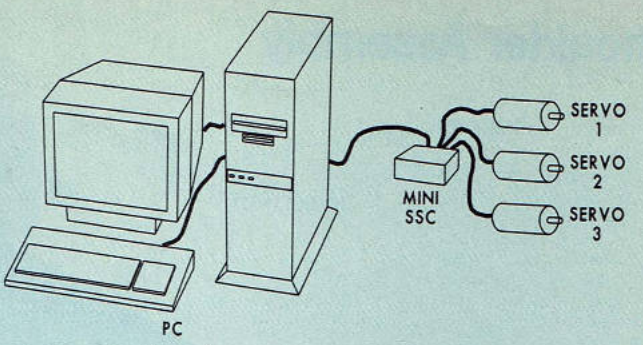


Fig.1: the robot has three servos controlled by a Mini SSC (serial servo controller). The SSC is controlled with a QBASIC program via the serial port on a PC.

Base Assembly

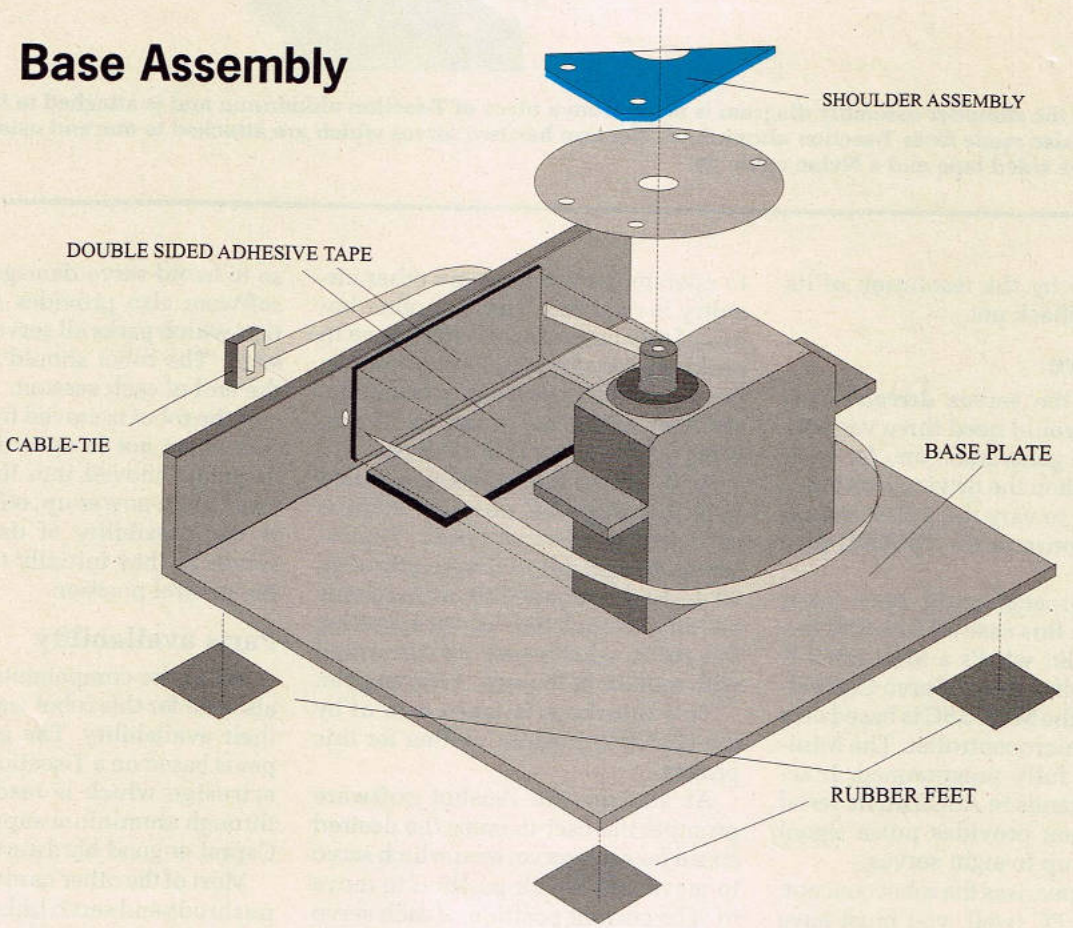


Fig.2: the base assembly uses an aluminium extrusion measuring 3mm thick, 120mm long, 80mm wide and 20mm high. A servo is centrally located against the vertical section and simply secured with double sided adhesive tape and a Nylon cable tie.

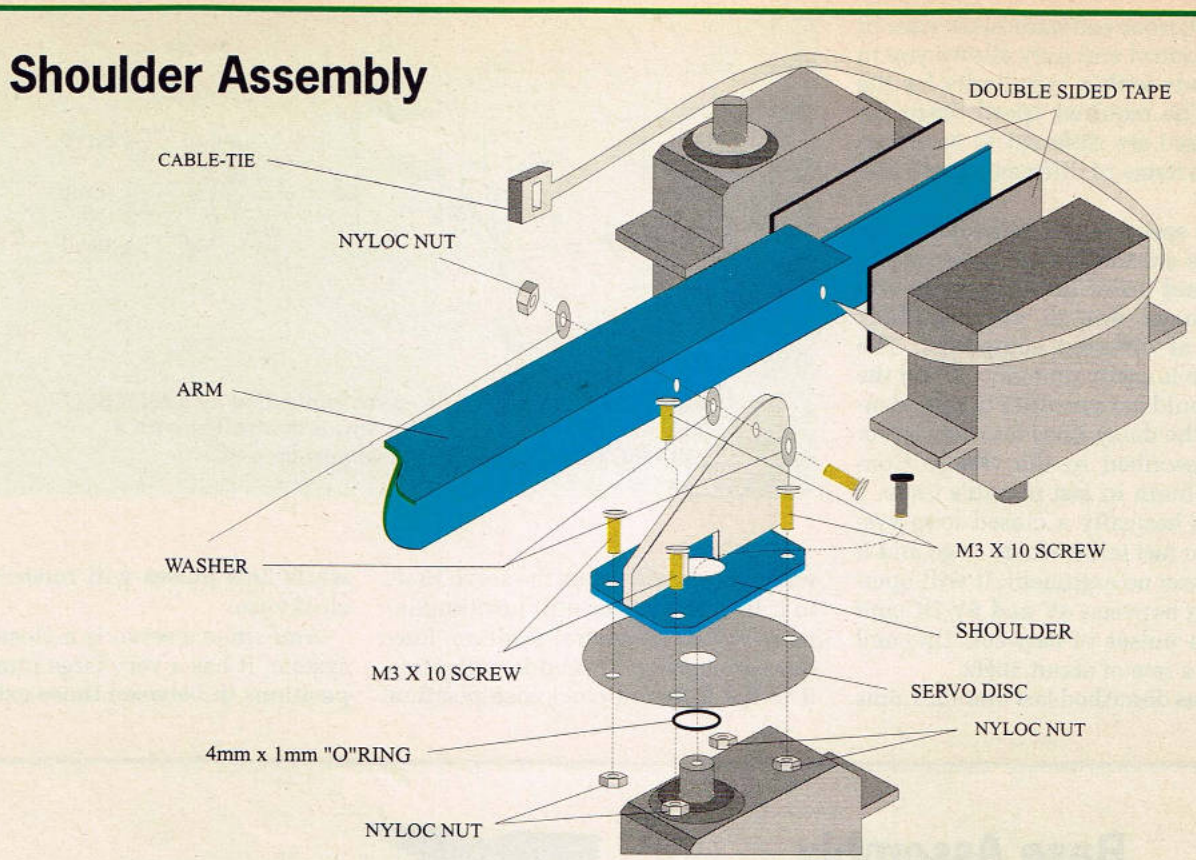


Fig.3: the shoulder assembly diagram is made from a piece of T-section aluminium and is attached to the arm, also made from T-section aluminium. The arm has two servos which are attached to one end using double sided tape and a Nylon cable tie.

limited only by the resolution of its internal feedback pot.

Servo drive

How are the servos driven? Normally, you would need three variable width pulse generators, one for each servo. And then the driving computer would need to vary the pulse generators in response to the QBASIC program.

That approach could have been taken but in this case a Mini-SSC has been used. Er, what's a Mini-SSC? It stands for Mini Serial Servo Controller. In turn, the Mini-SSC is based on a PIC-series microcontroller. The Mini-SSC comes fully programmed. It accepts commands in ASCII on its serial port and then provides pulse signal outputs for up to eight servos.

Fig.1 summarises the robot concept. You have a PC (well, you must have one if you want to control this robot) which feeds a serial port on the Mini-SSC and it is being used to control three servos. It generates all the pulses to operate the servos so no other circuitry is required. That's another bonus of this project – you don't have to build any electronics circuit boards; the Mini-SSC can be purchased assembled and read to go. Or if you want, you can buy it in kit form.

As it stands, the software supplied with the Mini-SSC does not address the problem of servo speed. Typical servos are capable of rotating through 90 degrees in about 350 milliseconds but that is much too fast for operating this robot, whether we are concerned with motion of the arm or the gripper.

This drawback is taken care of by the QBASIC program written for this project.

At startup the Ausbot software prompts the user to enter the desired speed for each servo, then which servo to move and which position to move to. The current position of each servo is also printed at the bottom of the screen, along with the speed.

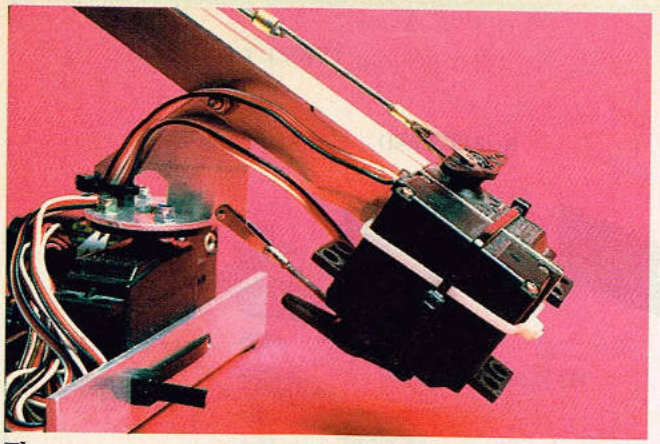
The Mini SSC starts in position #127, the servo neutral, on power-up, so to avoid servo damage the Ausbot software also provides a park function which parks all servos at position #127. The robot should be parked at the end of each session.

If the robot is moved from this position when not in operation it should be gently moved into the park position before power-up, otherwise there is the possibility of damage to the servos as they initially try to take up the neutral position.

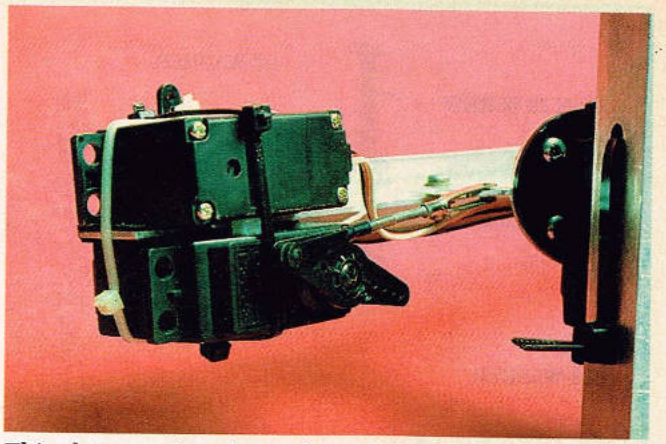
Parts availability

All of the components and materials used for this robot were chosen for their availability. The arm and gripper is based on a T-section aluminium extrusion which is readily available through aluminium suppliers such as Capral or good hardware stores.

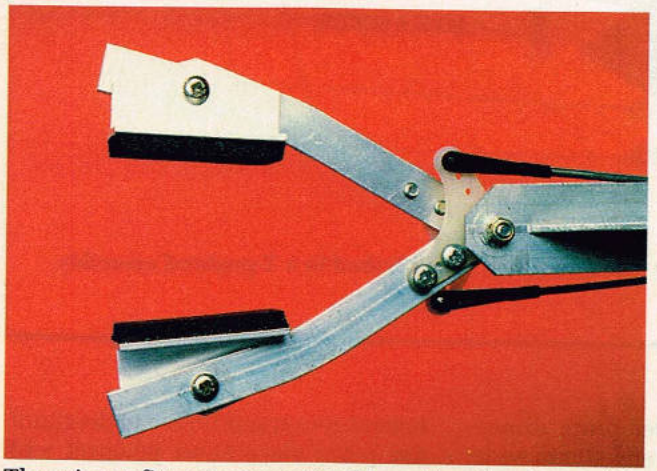
Most of the other hardware involves pushrods and servo links which again are readily available from most model stores under the "Kwicklink" brand name. The parts for the prototype were purchased from Vaggs Radio Models



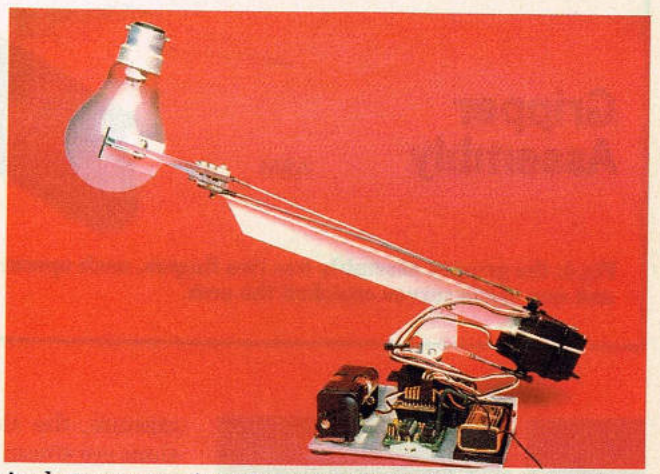
The two servos attached to the arm operate the gripper and provide the vertical motion. The third servo at left rotates the arm on its base.



This close-up view shows the underside of the arm at the servo end. Note that one servo is mounted upside down with respect to the other.



The gripper fingers are operated by a Y-pushrod assembly linked to two bell cranks. The other end of the pushrod assembly goes to one of the servos on the end of the arm.



Ausbot can open its gripper to 105mm wide in 254 steps of 0.413mm. With this sort of resolution this robot can pick up an egg (or a light bulb) without breaking it!

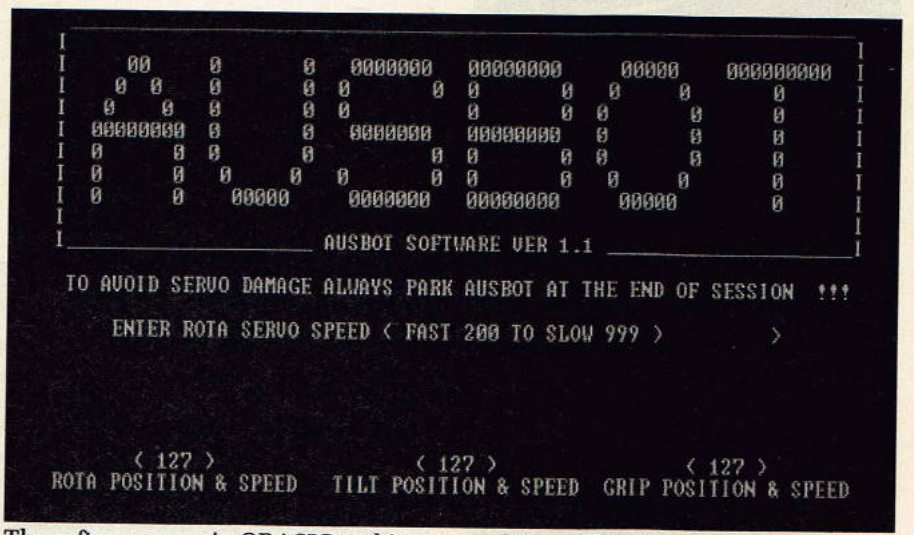
at Miranda NSW. Phone (02) 9525 5797.

You will be able to put the whole project together with just a soldering iron, a drill, a hacksaw and a file or emery paper, a screwdriver and a spanner.

Building it

There are three major assemblies in the robot. These are the base assembly, the shoulder assembly involving two servos and the arm, and the gripper assembly, the latter involving another servo, a couple of pushrods and two bell cranks.

Let's start with the Base Assembly – see Fig.2. This involves a length of aluminium extrusion measuring 3mm thick, 120mm long, 80mm wide and 20mm high. A servo is centrally located against the vertical section and simply secured with double sided adhesive tape and a Nylon cable tie.


AUSBOT SOFTWARE VER 1.1
TO AVOID SERVO DAMAGE ALWAYS PARK AUSBOT AT THE END OF SESSION !!!
ENTER ROTA SERVO SPEED (FAST 200 TO SLOW 999)
(127)
ROTA POSITION & SPEED
(127)
TILT POSITION & SPEED
(127)
GRIP POSITION & SPEED

The software runs in QBASIC and is easy to drive. All you have to do is enter data at the screen prompts.

The servo is fitted with a "servo disc" and this attaches to the shoulder piece. This is shown in detail in the Shoulder Assembly diagram – see Fig.3.

Made from a piece of T-section alu-

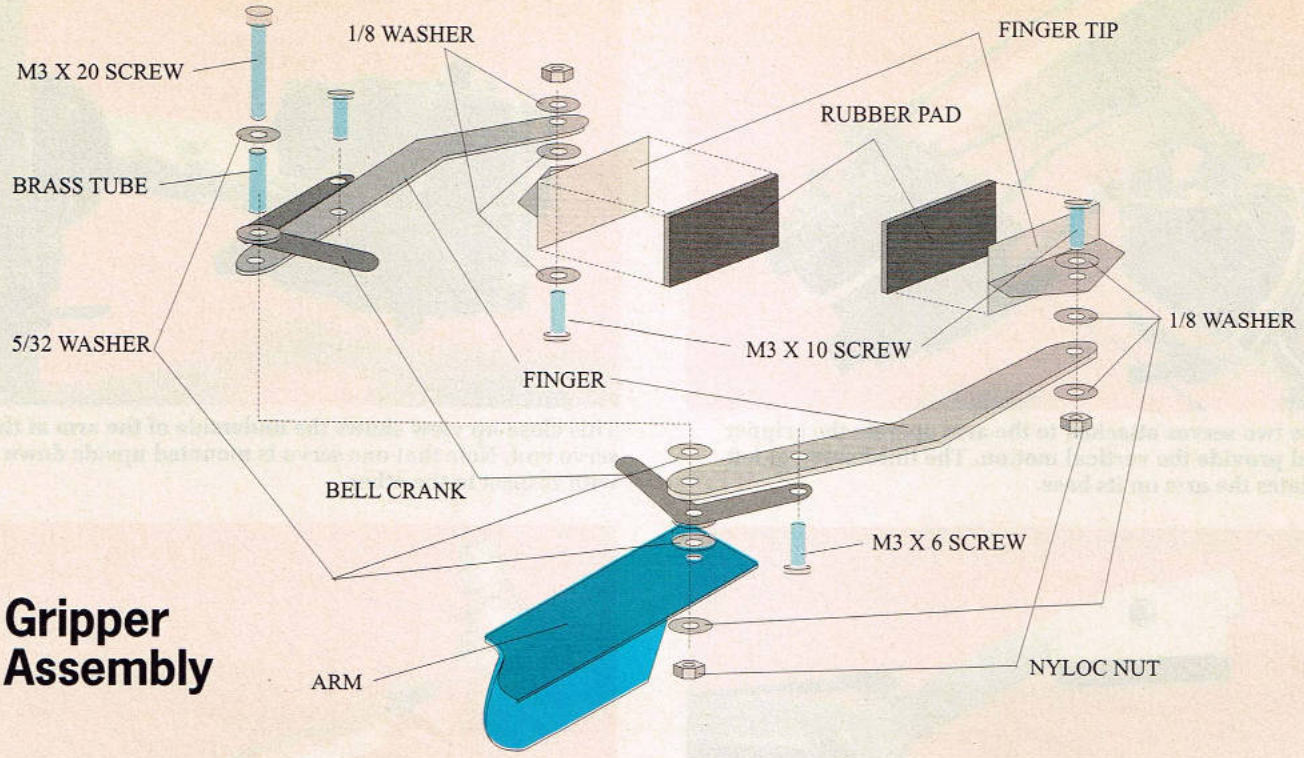
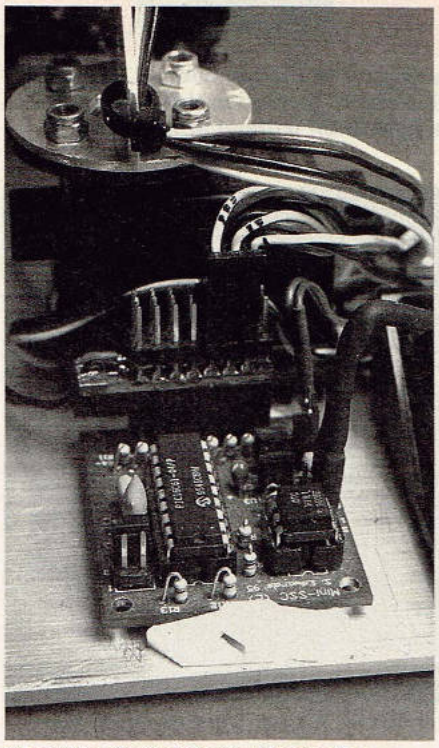


Fig.4: the gripper assembly has two fingers, each operated by a standard bell crank linked to a Y-pushrod assembly and one of the servos attached the arm.



The Mini Serial Servo Controller (Mini-SSC) is based on a PIC-series microcontroller and comes fully programmed. It can be purchased fully assembled and ready to go.

minium, the shoulder piece dimensions are 40mm high and 40mm wide. The other dimensions can be estimated from Fig.3. Attached to the shoulder is the arm, made from T-section aluminium, 20mm x 20mm and 270mm long. The arm has two servos which are attached to one end, again with double sided tape and a Nylon cable tie.

Both of these servos are fitted with standard servo arms, one at top to operate the gripper and the other below, to provide vertical motion. This lower servo arm is linked to the shoulder piece via a short pushrod with Kwicklink attached.

Finally, there is the Gripper Assembly which is shown in Fig.4.

The Gripper Assembly has two fingers, made from 10 x 3mm aluminium flat bar, 95mm long. Each finger is operated by a standard bell crank linked to a Y-pushrod assembly with three Kwicklinks. Each finger has a swivelling fingertip fitted with a rubber pad. These allow the fingers to grip smooth or irregular objects. **SC**

Kit Availability

As already indicated, this project requires little more than a soldering iron and a few other tools. It will be available as a full kit of parts and working drawings. Most people should only take a few hours to put it together.

All the parts for this robot and the software are available from Oatley Electronics who own the design copyright. Their address is PO Box 89, Oatley, NSW 2223. Phone (02) 9584 3563; fax (02) 9584 3561. The prices are as follows:

Software disc plus copies of detailed plans	$14.00
Mini SSC	$55.00
Kit of machined aluminium parts	$21.00
Servo kits	$15.00 each

Please add $5 for postage and packing.

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$45

JAYTECH 25 MHZ DUAL TRACE CRO

Brand new model with 5" screen and suited to a wide range of applications. Features include a deflection coefficient of 5mv/div to 20V/div in 12 calibrated steps. It also gives algebraic ADD, SUBTRACT, INVERT & X-Y modes. The time base range is from 0.5µsec/div to 0.2 sec/div in 18 calibrated steps. A continously variable uncalibrated control between the steps, along with X5 expansion extends the fastest sweep speed to 40nS/div approx. Variable hold/off, in addition to multimode triggering, provides versatile triggering up to 40Mhz.

SUPPLIED WITH 2 PROBES.
Cat. QC-1900 NEW
$699

JAYCAR KITS

VIDEO ENHANCER & STABILISER REF: EA NOV. 97.

NEW
Improve the quality of images from poor quality video tapes, and reduce degradation when you are making copies. Also includes circuitry which can give more stable viewing of video signals, by stripping out "piggyback" information like vertical - interval test signals and teletext data. The Jaycar kit includes box, punched & silk screened panels, transformer and all specified parts. Cat. KA-1798
$69.95

LINE CARRIER LINK NEW

Refer EA Nov 97 This kit simply controls mains operated devices through 240V mains outlets without the trouble of messy wiring or infra red links. Great for home automation. Kit includes all quality electronic components, PCB, box with silk screened front panel.
Cat. KA-1799 **$69.95**

"FULL HOUSE" POWER DRIVER BIT SET

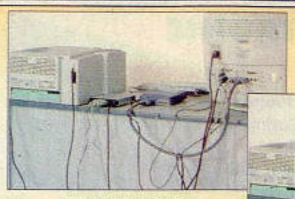
All the weirdo driver bits in one go!! -The set consists of 32, of the driver bits that you don't normally see. You don't get any slotted, Phillips or Posidrive bits. You do get: •4 x Tri - wing, size 1, 2, 3, and 4 •9 x Torx (tamperproof), size T8, T10, T15, T20, T25, T27, T30 and T35 •4 x Pin drive (snake), size 4, 6, 8 and10 •6 x In - Hex (allen), *metric, size 2, 2.5, 3, 4, 5 and 6 •6 x In - Hex (allen), *imperial size 5/64", 3/32", 7/64", 1/8", 9/64" and 5/32" •3 x Torque Set, size 8, 9 and 10. With this you get a hex driver with magnetic retainer, all in a nifty plasticy - rubber holder that is smaller than a deck of cards! (67 x 45 x 30mm). you will never get stopped by a wacko screw ever again!! Cat. TD-2035

SAVE $10 Now Only $19.95

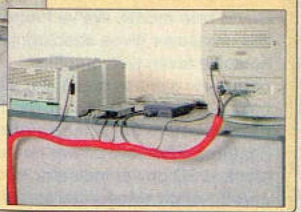
CONTROL THAT MESS OF CABLES BEHIND YOUR PC OR HI FI

NEW

Sometimes simple ideas are the best. This device is a length of flexible corrugated conduit which is split lengthwise. You use it, with instructions provided to trunk all cables leading to and from equipment into one neat bundle which fits inside the conduit. Cables that branch off simply exit from the slit! It makes for a really neat computer or Hi Fi installation! Also included in the kit are wire ties and special coloured labels to enable you to keep track of individual leads once the whole lot is bundled up! Conduit is grey in colour, 2m long and 22mm dia. (expandable).
Cat. HP-1230



WITH WIRE MANAGER



WITHOUT WIRE MANAGER

Only $19.95

100W 12V HALOGEN GLOBE

NEW

These are used in hand held spotlights and are extremely bright. Fitting and contact is by 2 pins which are 6mm apart. Length including pins is 40mm. Do not touch the glass with your fingers. Ideal for experimentors.
Cat. SL-2724 **$3.95**

MAINS (TWIN/EARTH) HOUSE WIRING CABLE

NEW

Twin Earth Flat Cable
1.0 sqmm 1/1.13, 10 amp (lights)
Cat. WB-1565 **$1.20/m or $95/100m**

Twin Earth Flat Cable
2.5 sqmm 7/.067, 20 amp (power)
Cat. WB-1568 **$1.75/m or $140/100m**

10 metres or more - less 10%

BLADE FUSES

MINI BLADE
Used in cellular phone hand free kits etc.
3A Pink Cat. SF-1910 5A Yellow Cat. SF-1912
$0.75 ea

MAXI BLADE
Used in big power amps etc.
20A Yellow Cat SF-1930
40A Orange Cat SF-1934
60A Grey Cat SF-1938
$5.95 ea

12 VOLT COMPACT FLUORESCENT LAMPS

NEW

Its a common known fact that compact fluorescent lamps use less power to give the same lighting as normal lamps. We have 2 new lights available. These are ideal for caravans, boats, cars, bush houses etc.

PL9W CABIN LIGHT

This uses a 2 pin PL9 watt tube,

which is about equal to a 60 watt globe. There is also a 3 watt courtesy light included, which can be used to give a small amount of light - (to see steps etc). An electronic ballast is used, guaranteeing low current consumption, and it is protected against incorrect battery connection. A 3 position rocker switch is used - centre is off, one way turns the courtesy light on, and the other way turns the compact fluro tube on. This lamp gives out an amazing amount of light when compared to the tubes which are only 125mm long. Current consumption is about 1 amp. Size is 282(L) x 81(H) x 38(D)mm. Cat. ST-3010 **$32.95**

Replacement Tube
Cat. ST-3011 **$6.95**

2D 16W SQUARE LIGHT

This unit uses the compact fluro tube called 2D, which is rated at 16 watts, which would be roughly equal to an 80 watt globe. It would be ideal to mount directly over a table, as it has a wide light dispersion. It also has a 3 position switch, with a 3 watt courtesy light included. Can be mounted either surface or recessed mount. Includes an electronic ballast. size is 160 x 160 x 45(D)mm. Current draw is 850mA.
Cat. ST-3012 **$42.95**

Replacement Tube
2D 16W Cat. ST-3013
$16.95

A CHRISSY PRESENT FROM YOU TO YOU?

Use this month to upgrade your multimeter. Get this: Autorange, 3.75 Digit 3260 Count plus Bargraph, Capacitance, Frequency, Data Hold, Continuity Buzzer, Transistor & Diode Test, 10 Amp, includes Holster.
Refer catalogue page 20 for full info. Cat. QM-1530

Normally $89.95 Save $20
Christmas Sale Price $69.95

SHORT CIRCUITS

IDEAL FOR KIDS!

Short Circuits assumes they know nothing about electronics. The book shows you what electronic components look like and how they work. There are 21 projects to build and all the components are supplied to build all the projects. There is no soldering required and all components are mounted on a baseboard with springs. Some projects are: •Short circuit tester •Police siren •Sound effects •Light chaser •Solar powered radio •Amplfier •Buzzboard & more.

SHORT CIRCUIT BOOK & PROJECT KIT
Cat. KJ-8502 **$24.95** *Used in Schools

PLUG INTO GREAT SAVINGS THIS XMAS! 200mA for free!!!

Christmas time is heavy on batteries, so why not eliminate them? The Jaycar MP-3012 gives 3.0, 4.5, 6.0, 7.5, 9.0 & 12V at up to 500mA (unregulated, so be careful) with 7 polarity reversible plug adaptors at a normal price of $24.95. This month you can have one for less than the price of a 300mA version!
Cat. MP-3012 **Normally $24.95 Save $6**
This month only $18.95

MAIL ORDER CORNER

These products are ONLY available by ordering on our Mail Order Dept. Direct. Simply call 1800 022 888 and have your credit card handy! **P&P charges $4**

OK SOLDER STATION

Buy in December at $199 & receive free 1Kg. roll of solder worth $24.95 Cat. NS-3002

Cat. NS-3002
Only $199
Cat. TS-1620

HARD TO GET PANEL METER SALE!

All supplied with mounting hardware.

Description		Comments	Price (ea)
0-300VAC	MU65 Style 65W x 60Hmm	Class 2.5	$10
0-40VDC	MU65 Style 65W x 60Hmm	Class 2.5 BRAND NEW	$5
0-60VDC	MU65 Style 65W x 60Hmm	Class 2.5	$5
0-20VDC	45mm Square	Really Cute!	$6
0-10ADC	MU65 type 65Wx60Hmm & shunt	Class 2.5	$15
0-60ADC	MU65 type 65Wx60Hmm	50mV Shunt rqrd	$6
0-75ADC	80mm Square	50mV Shunt rqrd	$6
0-100ADC	80mm Square	50mV Shunt rqrd	$10
-30/0/+30ADC	70Wx60H University Brand	Shunt rqrd Aust made	$30
40/50/60Hz	Analogue freq meter 80x80mm, 100mm deep	220-240V	$40

Small quantities of other meters available - please ask!

SHUNTS TO SUIT METERS

We also have a quantity of beautifully made high current shunts. They are hand made by instrument fitters (a lost trade?) and feature brass/bronze silver soldered electrical work. Many are mounted on bakelite plinths. Prices range from $5-$10, depending on size. Most shunts are boxed and present as new, some are unboxed and are therefore slightly soiled. All are brand new however. From 50mV@60A to 75mV 250A. Ask for details when ordering.

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

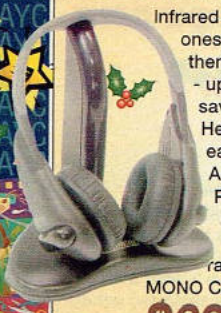
2 WAY ELECTRONIC CROSSOVER

Brand new model. We've found this crossover gives absolutely no noise (even with amplifier crossover gains at max.) and with bass boost on. The crossover did not clip before the source signal.
Features: •Remote power terminal block •LED power indicator •Output level controls •Bass boost on/off switch •Mono/stereo switch.•Gold plated RCA in/out socket •Heavy duty metal case (will be grey in colour).
Cat. AA-0450

NEW

Only $89.95

NEW GENERATION RF WIRELESS HEADPHONES



Infrared cordless headphones are better than wired ones. These new RF headphones allow you to use them with complete freedom all around your house - up to 30 metres away. Jaycars' direct importing saves big $$ over others' selling prices. Headphones includes a volume control for each ear. Includes mains adaptor to run from 240V. 2 x AAA batteries required. Energiser batteries $4.95 Pair Cat. SB-2380.
Specifications: •RF TX frequency 40.68mHz •Frequency response 50Hz to 18,000Hz •S/N ratio >50dB(A) •Transmit distance 30 mtrs.

MONO Cat. AA-2003 **$69.95 PR**

STEREO Cat. AA-2004 **$99.95 PR**

SOUND/LUGGAGE/ SAFETY BELT

Another surplus stock purchase!

NEW

This is a really nice quality neoprene carry belt. It's designed for a Walkman but is ideal as a safety pouch, like you see all the tourists wearing. It has one main compartment (size about 115W x 50D x 130H approx.) There is a very small compartment which could hold a cigarette lighter, keys or folded notes, and two others which are designed to hold AA batteries, etc. The belt is adjustable, and the oversized flap on the big compartment keeps out rain.
Cat. AR-1790

Retail Price $24.95

Jaycar Price $9.95

NEW COMPUTER LEADS

NEW

SCSI-1 DB25M TO CENT 50M
Length 1mtr.
Cat. PL-0951 **$12.95**

SCSI-2 HALF PITCH 50M TO DB25M
Length 1mtr.
Cat. PL-0954 **$29.95**

SCSI-2 HALF PITCH 50M TO CENT 50M
Length 1mtr.
Cat. PL-0952 **$32.95**

SCSI-2 HALF PITCH 50M EACH END
Length 1mtr.
Cat. PL-0953 **$34.95**

SCSI-3 HALF PITCH 50M TO 68M
Length 1mtr.
Cat. PL-0955 **$49.95**

SCSI-3 HALF PITCH 68M EACH END
Length 1mtr.
Cat. PL-0956 **$59.95**

SCSI-3 HALF PITCH 68M TO CENT 50M
Length 1mtr.
Cat. PL-0957 **$44.95**

SCSI-3 CENT 50M TO CENT 50M
Thick cable. Length 60cm.
Cat. PL-0958 **$19.95**

GENDER CHANGER CENT 50F TO CENT 50F
Centronics 50 pin female either side.
Cat. PA-0945 **$16.95**

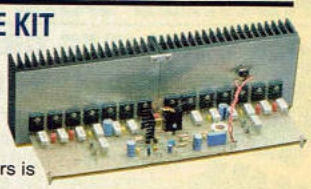
NEW KITS FROM JAYCAR

HEAVY DUTY 10A 240VAC MOTOR SPEED CONTROL KIT

NEW

REFER: SILICON CHIP NOVEMBER, 1997
Using switchmode power supply techniques, this is an outstanding controller that will give you smooth control from zero to full speed. Use it to control drills, lawn edgers, routers, circular saws and other appliances with brush type motors. Kit includes dust proof case, PCB, silk-screened front panel all specified electronic components.
Cat. KC-5235 **$119**

500W POWER AMPLIFIER MODULE KIT



REFER: SILICON CHIP AUG, SEPT, OCT 97
Kit includes PCB plus all electronic components. Transformer MT-2190 $169.00, pre-tapped heatsinks (2 required) HH-8555 $42.50 all available separately. **10,000uF CAPACITORS**. Note that the ripple current rating of our capacitors is 8.1A. Some suppliers have only 5.0A capacitors. Normally $39.95 ea. Buy the 8 together for only $35.95 ea, saving $32 Cat. RU-6712.
Cat. KC-5231 **$219**

TV COLOUR PATTERN GENERATOR KIT

REFER: SILICON CHIP JUNE JULY, 1997
Generate colour bars and patterns or customise your own using low cost software available from the magazine. Supplied with PCB, pre-programmed EPROM, case, panels and all components.
Cat. KC-5224 **$149.50**

REMOTE POWER UP KIT FOR PC'S

REFER: EA JUNE, 1997
Switch your PC and other appliances over the phone line. Case, PCB and components included.
Cat. KA-1794 **$49.95**

OPEN AN ACCOUNT WITH JAYCAR

SOUNDVISOR CD ORGANISER

NEW

Soundvisor is an easy way to organise compact disks in your car. Simply attach soundvisor with its elastic straps to your car's sunvisor. Ultra soft cotton pockets firmly hold and protect 6 CD's. There is also 2 pen holders, a mesh pouch for sunglasses and zippered map compartment are included for added convenience. Just flip down your visor to retrieve or replace a CD. Flip it up and put CD's out of sight. Fits all car visors.
Size 313(L) x 150(H)mm. Cat. AR-1780

Retail Price $19.95

At Jaycar Only $14.95

30 PIECE SECURITY (TAMPER PROOF) BIT SET

NEW

A totally comprehensive driver bit set for servicing almost any appliance! This set consists of: Torq - set bits 6, 8, 10; Tri - wing bits 1, 2, 3 and 4; Spanner (snake-eye) bits 4, 6, 8 and 10; Tamper proof hex bits 5/64", 3/32", 7/64", 1/8", 9/64" and 5/32"; Torx bits T8H, T10H, T15H, T20H, T25H, T27H, T30H, T35H and T40H. In addition to this you get a nifty bit driver with 1/4" hex drive socket and magnetic and retainer plus storage for bits in the handle. A 1/4" square drive to hex male adapter and female version of the same thing is also included. All bits are in chrome - vanadium so they will last. Hey! This is only 29 parts you say! True - but we're counting the case. How pathetic.

Cat. TD-2001 **Only $24.95**

PS. A big Pommy parts Company is asking $64 for exactly the same set!!

TURN YOUR SURPLUS STOCK INTO CASH!

Jaycar buys surplus/distress stock of most electronic products from components to built products. If you have marketable quantities of stock you need to clear contact us on Ph: 02 9743 5222 Fax: 02 9743 2066

NEW KEYSWITCHES

WE'VE MADE A SURPLUS DEAL OF 2 KEYSWITCHES. NEW

SPST KEYSWITCH

This is a standard type key-switch, with 2 tubular keys supplied. 19mm mounting hole. Key removeable from both positions. Cat. SM-1033

Only $6.95ea

SPRING RETURN KEYSWITCH NEW

The best way to describe this switch is to say its like a car ignition switch. Turn the key to the right, and it spring returns. Contacts are single pole, with both N/O and N/C available, and can be used simultaneously. Cat. SM-1034

Only $8.95ea

SINGLE SCREENED AUDIO CABLE

This is the same as our WB-1500 standard cable, except that the OD is 4.6mm instead of 2.6mm. Ideal for for longer runs. Cat. WB-1520

Was $1.70m or $116/100m

Now 50c metre or $40.00/100m Roll.

HIGH CURRENT POWER CABLE

The current stock we have is not quite up to full 4G and 8G specs. Its slightly smaller, but will still do the job perfectly in 99% of installations. Your chance to save !! SAVE

8GA POWER CABLE

Normally $2.95 mt. / $220 100mt. roll.

Now $1.95 mt. / $170 100 mt. roll.

RED Cat. WH-3070

BLACK Cat. WH-3072

4GA POWER CABLE

Normally $7.95 mt. / $325 50mt. roll.

Now $5.50 mt. / $225 50 mt. roll.

RED Cat. WH-3074

BLACK Cat. WH-3076

SPEAKER CABLE

HEAVY, HEAVY DUTY.

2 x 79/0.2mm

Cat. WB-1712

$2.60 mt

JUMBO.

259 x 2

Cat. WB-1732

$3.70 mt

150 WATT SWITCHMODE POWER SUPPLY DEAL

Another surplus bargain. These are removed from new equipment. Input is 240V or 110V via an IEC socket. Outputs are via 9 pin launcher headers. There is even a 2 way launcher for a cooling fan. Output voltages are: •3 x +5 volts @ 10 amps total •1 x +12 volts @ 2.5 amps total •1 x -12 volts @ 1.5 amps total •1 x +24 volts @ 160mA total. Supplied with performance spec. Board size 287(L) x 126(W)mm. Limited quantity available. Cat. MP-3045

Was $39.95

Now $29.95

OFFSET RATCHET SPANNER SET

5 double ended tools. Sizes: 5.5, 6, 7, 8, 10, 11, 12, 13, 14, 17mm Cat. TD-2112

$24.95

Jaytech DIGITAL CAPACITANCE METER

Includes holster. Buy yourself one for Christmas! Cat. QM-1572

Cat. Price $89.50

Dec. $69.50 Save $20

12V HALOGEN SPOTLIGHT

One million candle power. Handheld and stand. Cat. ST-3028

Was $29.95 Save $9.95 Dec $20

DATA BANK CALCULATOR WATCH

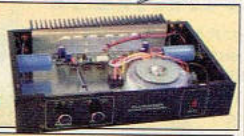
Cat. XC-0260

Was $19.95

Dec. $10

Save $9.95

300W SUBWOOFER AMP KIT



Output power 240WRMS / 8 ohm, 430WRMS / 4 ohm. Complete kit.

Cat. KA-1770 **$349.50**

0-30VDC 2.5AMP DIGITAL VARIABLE LAB SUPPLY

Cat. MP-3082

$199.50

NEW

IDEAL XMAS PRESENT

6 WAY POWER OUTLET WITH MAINS FILTER & TELEPHONE LINE PROTECTION

See 97 Cat. page 87 for full details. Cat. MS-4035

Was $44.95 Save $5

DEC $39.95

VIDEO DOORPHONE NEW

See who is at your front door before opening it! You simply can't be too careful these days. When a visitor presses the doorbell, the video monitor automatically turns on, and you can see who is at the door. You can talk to them, and if you don't know them, ask them their business, without opening the front door. With the optional door release, you can remotely open the front door, and let the visitor in if you wish. The camera has IR LEDs for night illumination, and comes with installation hardware for flush or surface mounting. Supplied with clear instructions can easily be mounted by the family handy person. 1 year warranty. Cat. QC-3410

DOOR RELEASE TO SUIT $34.95 Cat. QC-3415

Only $469

DSC 5 Sector Alarm Deal

INCLUDES:

	NORMAL PRICE
1 x DSC 5 zone alarm/dialler	$285.00
3 x Bellmate 100 PIRs	$119.85
1 x mains 3 wire power supply	$24.95
1 x 6.5Ah backup battery	$43.50
2 x reed/magnet switches	$11.50
1 x strobe	$19.95
1 x metal siren cover	$29.95
1 x siren horn	$25.95
1 x internal siren	$19.95
2 x deterrent stickers	$4.00
100 m of 6 core alarm cable	$88.00
NORMALLY PAY	$672.60

Cat. LA-5460

DSC Security Products

This system includes the DSC 5 sector alarm panel with Austel Approved dialler. Connect it to an alarm company or it can phone you or your neighbours etc.

THE BEST

ONLY $599

2KG DIGITAL SCALES

Cat. QM-7245

$49.95

WORLD TIME CALCULATOR WATCH

1/2 PRICE

Features •12 Cities plus 1 free zone •Time •Alarm •Calculator. Cat. XC-0270

Was $12.95

Now $6.50

240V TIMERS

MECHANICAL Cat. XW-0400

$19.95

DIGITAL Cat. XW-0402

$47.95

MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888

4 DOOR CENTRAL DOOR LOCKING KIT

Kit includes 2 master and 2 slave solenoids and the power relay. Be careful! Other kits advertised only have 1 master & no relay box! Includes wiring. You can't beat our price!

Cat. LR-8830 Cat. Price $89

Only $59 SAVE $30

JayTech BUDGET CUTTERS & PLIERS

Due to supply problems, we have found a new supplier of our cutters and pliers. Our new suppliers offer better quality tools.

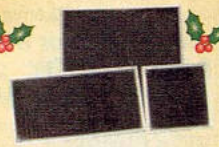
CUTTERS
Cat. TH-1882

PLIERS
Cat. TH-1884

BACK IN STOCK

$7.95ea

SOLAR PANELS



1 WATT	2 WATT	4 WATT
6 VOLT	12 VOLT	12 VOLT
ZM-9020	ZM-9024	ZM-9026
$19.95	$37.95	$67.95

ALARM STICKER

CAR Sticks to inside of window. Size 72x32mm. WARNING

Cat. LA-5100 **$1ea**

HOME Sticks to outside of window, or most surfaces. Size 120 x 80mm.

Cat. LA-5102 **$2.00ea**

"FLIGHT CASE" STYLE TOOL BAG

Cat. HB-6372 **Was $89.95**

Dec. $59.95

Save $30

IDEAL XMAS GIFT

ARLEC SECURITY BEAM

This security beam is ideal for use in shops, reception areas, factories, warehouses or any unattended doorway or entrance area. It uses an infrared beam, and a buzzer sounds when the beam is broken. Ideal range is 2 - 8 metres. Complete with mains adaptor. Cat. LA-5190

$195

JUMBO HYGROMETER

Reads the temperature and humidity with large display. QM-7202

Now Only $49.95

FREE DRILLS WITH DRILL

Buy our super drill set in December for $59.95 and receive free a TD-2400 drill pack worth $13.95. The drill pack includes 10 drills - 1 x 3.5mm, 2 x 1.2mm, 3 x 1mm and 4 x 0.8mm. The drill set includes 12V drill, an assortment of accessories and a 240V plugpack. See 97 Cat. page 103 for full details. Cat. TD-2460

$59.95 THE LOT

PAPST TURNTABLE MOTOR

See July or August Adverts for full details on these quality German made PAPST motors.

Cat. YM-2700 **Was $49.95 Oct $39.95ea**

REMOVEABLE HARD DISC CARRIER

Ever wanted to transport large amounts of information without using a Zip Drive or a CD ROM writer. Now you can. Use any type of 3.5" or 2.5" hard disk between two PC's. •Fits a standard drive bay.

IDE KIT Cat. XC-4670 **$39.95**

WELLER PORTASOL

Cat. TS-1720 **$49.95**

UHF/VHF FRINGE BARGAIN ANTENNA

The big brother to our best selling antenna. Its bigger and is ideal for using in fringe area locations. Receives UHF channels 28 to 36 (band 4) and VHF channels 0-11. This antenna is $50 less than the brand name equivalent. Boom length 2mts., 7 x VHF elements, 12 UHF elements and includes 75Ω balun to run coax. Please note that the big VHF elements are 1.3mts. long, so if you live in an area that very large birds frequent, beware!

Cat. LT-3142

AMAZING PRICE!

Only $79.95

CCD MINI CAMERA

This mini camera comes in a black metal case that measures only 35(W) x 35(H) x 15(D)mm!! Unbelievably small. Supplied with mounting bracket and lead with DC socket and BNC socket. Requires 12VDC, and connects to any standard video input - like your VCR, or via an RF modulator to a TV aerial.

Cat. QC-3470 **Only $145**

CCD BOARD CAMERA

Cat. QC-3460 **$125**

LOOKS LIKE A PIR CAMERA!

Includes infra red LEDs for night illumination.

Cat. QC-3450 **$159.50**

INFRA RED LEDS FOR CCD CAMERAS

$1.25ea or 10 for $10

Use our ZD-1945. Specs are in the 97 Cat. P154. Cat. ZD-1945

POCKET SHIFTER MULTITOOL

Includes •Shifter with 18mm jaw opening •Phillips head screw driver •Slotted screwdriver •File •Canopener •Bottle opener •Knife •Supplied with holder and belt clip •Made in Taiwan.

Cat. TH-1905 **Was $19.95**

NOW HALF PRICE

DEC $10

UNIVERSAL CROSSOVER PC BOARDS

BUILD YOUR OWN CROSSOVERS

NEW

These brand new 2 and 3 way crossover printed circuit boards have been designed as a versatile method of building your own customised crossover that will suit just about any speaker system. They can be used on 4 or 8 ohm speakers, and even with a combination of both. They can be wired to give a max. of 12dB per octave, or by leaving some components out, they could be 6dB or a combination of both. Full instructions on how to select the various components for different crossover frequencies are included, as well as an attenuation table for tweeters. Inductors & capacitors are available from Jaycar see 97 Cat P47 2 WAY Size: 122x122mm. 3 WAY Size: 140x195mm.

2 WAY PC BOARD
Cat. CX-2605 **$11.95 ea**

3 WAY PC BOARD
Cat. CX-2606 **$14.95 ea**

GOLD SCART LEAD

1.5mtrs. long.
Cat. AV-6554

$14.95

2 CHANNEL DP REMOTE CONTROL SWITCH LATCHING & MOMENTARY

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Putting this in line (low level) with a standard car amplifier will give you an adjustable low frequency output for your sub woofer. Features Include:
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The ultimate book on Hard Disc Drives for personal computers. This book is ideal for any person who needs to know about drives at a hardware or "machine" level. Hardbound, it comes in at 430+ pages. The book begins with the listing of hard-drive development through to the latest refinements. Subjects covered include: Basic drive operation, media and heads, stepper motor servo systems, voice coil systems, data encoding and decoding, interface standards (all of them!) including latest ultra SCSI, QIC36, SA400 and future trends, controller setup and jumping, drive cabling, drive types, formatting, DOS partitioning, Macintosh and PC formats, Windows 95, hardware compatibility problems, common installation problems, trouble shooting, controller information, etc. (Phew!) In addition to this is full technical data on virtually every hard-drive ever made, including all pinouts!! It also covers CD-ROM drives, tape drives and even floppy drives!! Also included are lists of the authors benchmark tests for establishing drive performance. This is the most fantastic manual we have ever seen on any product, let alone such an arcane subject. The hard cover format welcomes continuous professional use.
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THE LATEST KITS

STEPPER MOTOR DRIVER CARD KIT WITH ONBOARD BUFFER

Ref: Silicon Chip Dec 1997

Eight of these new cards can be daisy chained and connected to one PC printer parallel port, with one card capable of driving a single motor. Each card can be coded with a different address making them individually selectable and, if the need arises, two or more can be jumpered with the same address in a master-slave setup. Being buffered, your PC can dump data into the card then carry out other tasks without being tied up. Kit includes PCB, heatsink bracket, hardware plus all specified electronic components.

Cat. KC-5236 **$55.00**

POWER SUPPLY KIT FOR STEPPER MOTOR CARDS

Ref: Silicon Chip Dec 1997

This power supply is capable of driving several stepper motor driver cards, depending on the current consumption of the motors. It can supply around 2 to 2.25 amps with moderate amounts of ripple with both 12V and 18VDC rails available. A +5V regulated supply for the logic circuitry is also included to readily power 8 or more cards. The kit includes high quality case, transformer, PCB plus electronic components.

Cat. KC-5237 **$59.50**

STEPPER MOTORS

All motors supplied with data and applications information.

	Cat. No.	Normally	With Kit KC-5236
SANKYO 7.5° Step Hi Torque	YM-2750	$28	$25
MINEBEA 7.5° 6Ω Coils	YM-2752	$20	$18
MINEBEA 7.5° 15Ω Coils	YM-2754	$16	$12

OTHER STEPPER KITS

KC-5157 (Drive 2 Motors) PC operated **$39.95**
KC-5226 (Manual Control) Drives 1 motor **$19.95**

LOUDNESS CONTROL KIT FOR CAR SOUND SYSTEMS

NEW

Ref: Silicon Chip Dec 97

Although its hard to believe, many modern car systems have loads of features but lack a loudness control. If you wish to retain the "power" of your music when forced to lower the volume, then this simple kit is the answer. Connects between your tape/CD and crossover, and accepts a line level input with a bypass switch and boost potentiometer included to control the final sound. PCB, quality gold RCA sockets, case plus elec components included.

Cat. KC-5239 **$24.95**

SPEED ALARM KIT FOR CARS

Ref: Silicon Chip Dec 1997

Designed with the same sensor in mind as the latest Commodore. Two push button switches select the speed at which the alarm will trigger in increments of 5km/h, with the designated speed indicated on a 3 digit LED display. When triggered, a piezo alarm sounds along with a visual indicator warning you to slow down. Speed is monitored by a magnet/sensor assembly attached to/near the driveshaft. Increase safety and avoid hefty fines and loss of points/license. The Jaycar kit includes cases, PCBs, front panel, red perspex lens, auto cable and connectors, all electronic components plus a free set of IC sockets.

Cat. KC-5238 **$89.50**

AUDIO MASKER KIT FOR TINNITUS SUFFERERS

Ref: Electronics Australia December, 1997.

Tinnitus is a term used to describe ringing in the ears, or any other form of perceived sound that doesn't come from an external source. For some it can be just an annoyance, for others it can become a nerve-wracking condition. This kit will provide some relief by generating a backround sound such as a strong rushing waterfall down to the soft sound of wind blowing through trees. Kit includes case, front panel, PCB plus all electronic components. 9V battery not included - use SB-2370 $3.40.

Headphones also required, use AA-2016 $4.95 Cat. KA-1800 **$24.95**

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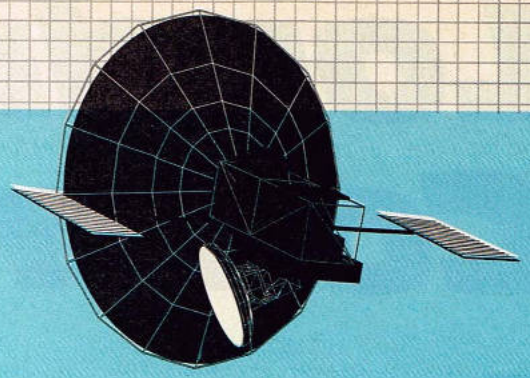

Compiled by GARRY CRATT*

Apstar 2R

Apstar 2R was successfully launched aboard a Long March 3B rocket from the Xiachang launch site in China on October 17. The satellite has 28 C band and 16 K band transponders, which can operate at 60W and 110W respectively. The satellite was expected to be in commercial service by the end of November. Officials from APT advise that over 50% of the satellite capacity has already been leased. The satellite will occupy 76.5°E longitude.

Asiasat 3

The launch date for Asiasat 3 has now been scheduled for December 12. This satellite will be launched to occupy 105.5°E, initially to be co-located with Asiasat 1 which will then be moved to 122°E longitude. We expect Asiasat 3 to be operational by mid-January, if the launch goes to schedule. Asiasat 3 will be launched from the Baikonur Cosmodrome in the Central Asian state of Kazakhstan using a Proton launcher.

Asiasat has a contingency plan should the launch fail and has purchased a "small" 6 transponder satellite, which could be moved to 122°E to occupy the allocated slot, ensuring it is not stolen by another (non-ITU) operator.

Palapa C1

As reported by various news agencies, engineers at the Satellindo uplink facility in Jakarta have realigned the antenna on this satellite to provide better performance in Australia and New Zealand. Initial test signals appeared on September 30, carrying CNBC programming, disappearing after a week or so. Palapa C1 is located at 150.5°E longitude and will be worth monitoring in future months.

Panamsat 2

Chinese broadcaster China Central Television (CCTV) has begun uplinking from Beijing directly to Pas-2, bypassing the double hop previously used via Asiasat 1 and the Pas 2 uplink facility in Hong Kong.

This means that CCTV can now uplink to both Pas 2 and Pas 4 from Beijing, considerably lowering operating costs. The network has advised they will be expanding to six channels. Pas-2 viewers can presently see CCTV3, 4, 5 and 9, all broadcast in PowerVu without conditional access.

Asiasat 2

New Guinea broadcaster EMTV, which moved to Asiasat 2 late September on 3760MHz horizontal, will move again as early as mid November. EMTV intend to switch to non-conditional access MPEG2, with SR 4333, FEC, on 4006/1144MHz vertical polarisation. Most free to air digital receivers will operate using these parameters.

Elsewhere on this satellite, Zaknet, a Kuwait based group uplinking out of the Subic Bay teleport in the Philippines, has commenced their one way internet service. Similar to Net On Air (which has yet to commence service), the system uses a standard modem connection for Internet requests and a special satellite receiver PC card connected to a satellite dish forms the return path. The combination allows data to be downloaded at rates up to 225Kb/s.

Optus B3

The Optus Aurora platform commenced testing in October. This platform will carry ABC and SBS (amongst others) digital services, once the current HACBSS BMAC service is terminated. There is expected to be a gradual rollout over the next 12 months.

Satellite Communications Catalog

Next month's issue of SILICON CHIP will feature a comprehensive 32-page catalog of satellite communications equipment from AvComm Pty Ltd.

* Garry Cratt is Managing Director of AvComm Pty Ltd, suppliers of satellite TV reception systems. Phone (02) 9949 7417. http://www.avcomm.com.au

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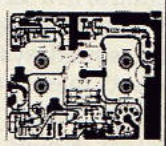

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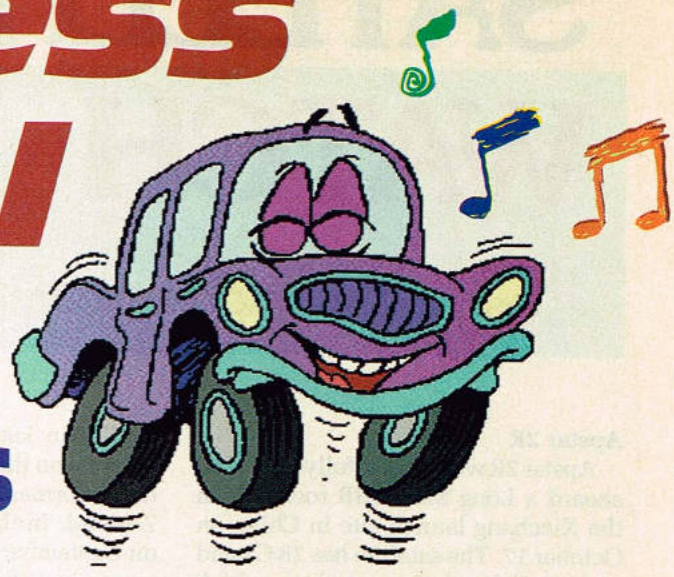
Loudness Control

For car hifi systems

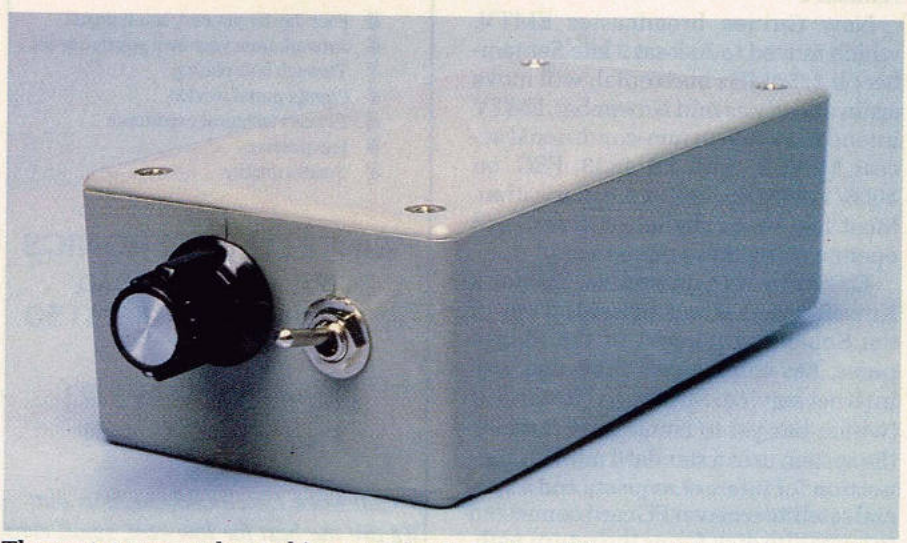


Most cars with big sound systems have loads of features but here's one they usually don't have – a loudness control. Now you can add a loudness control with this circuit which involves a quad op amp and not much else.

Design by RICK WALTERS

Why would you want a loudness control in a car? Well, contrary to what you might expect, not everyone with a big sound system in his or her car wants to cruise the boulevardes with the windows wound down and the levels wound all the way up all the time. For a start, it can give you a headache if you do it for long periods and the police tend to frown a bit . . . not to mention that it will ultimately send you deaf after a while. "What's that?" you say.

Using this loudness control will let you hear the highs and lows better without having to turn the wick up so far. It provides a similar function to the Loudness switch on many hifi amplifiers but does not rely on a special tapped volume control. But as often happens with articles of this sort, we're getting a little ahead of ourselves and we need to explain the theory behind Loudness controls.



The prototype was housed in a standard plastic utility case. The knob controls the volume while the switch allows the loudness circuit to be bypassed.

Our ears are not perfect, funnily enough. While they respond to an enormous range of sound levels, from whisper quiet to the roar of a jet engine, and with a frequency range from around 16Hz up to as high as 20kHz, we just don't hear all frequencies equally well, unless the sounds are very loud. In effect, when sound levels are low, we don't hear bass frequencies particularly well at all, and to a lesser extent, we don't hear the treble well either.

This has been well documented for many years and was published in October 1933 in the "Journal of the Acoustical Society of America" by H. Fletcher and W. A. Munson. Fletcher & Munson produced a famous set of curves, shown in Fig.1. These are "equal loudness curves" taken at sound levels from very soft (0dB) up to very loud (120dB). As you can see from these curves, at the softer levels, our ears are far less sensitive to bass and treble frequencies.

To partly compensate for this, some hifi amplifiers have Loudness controls. Most of these just boost the bass at lower volume settings but do not boost treble. Whether these controls should be on hifi amplifiers is argu-

able but many people like this facility so that is why we are presenting this project.

To understand what our Loudness control does, have a look at the curves in Figs.2, 3, 4 & 5. Fig.2 shows the frequency response at a low setting of the Loudness pot, with the control wound up 25% from the zero setting. As you can see there is about 10dB of bass boost compared to the mid-frequencies and about 8dB of treble boost. This goes a long way towards compensating for those hearing losses we're talking about.

In Fig.3 we have a similar set of curves but now the Loudness pot is at half rotation. You can see that the bass boost is slightly higher and the treble boost is slightly reduced compared with the curve in Fig.2. Fig.4 shows a similar story, with a reduction in the boost available. Finally, Fig.5 shows the frequency response when the Loudness control is fully wound up and now you can see that the response is virtually flat across the whole frequency range; ie, no boost at all.

The reason for having the boost cut back as you wind up the control is twofold. First, you don't need lots of boost when the music is very loud and second, by cutting back the boost so that the frequency response is flat, there is less chance of overloading the amplifiers and loudspeakers. This is most important because if you consistently overload your loudspeakers they will not only sound horrible but there is a big risk of burning them out.

Fig.6 shows how the Loudness control could be added into a typical car sound system. It is interposed between the cassette/tuner and the electronic crossover. The line level signal from the cassette/tuner will typically be no more than 1V RMS. In use, you would first wind up the Loudness control to its maximum setting and then set the volume control on the cassette/tuner to give the highest setting that you are ever likely to want. From then on, you use the Loudness control to set the audio level you want and you can use the bypass switch to cancel the bass and treble boost if you desire.

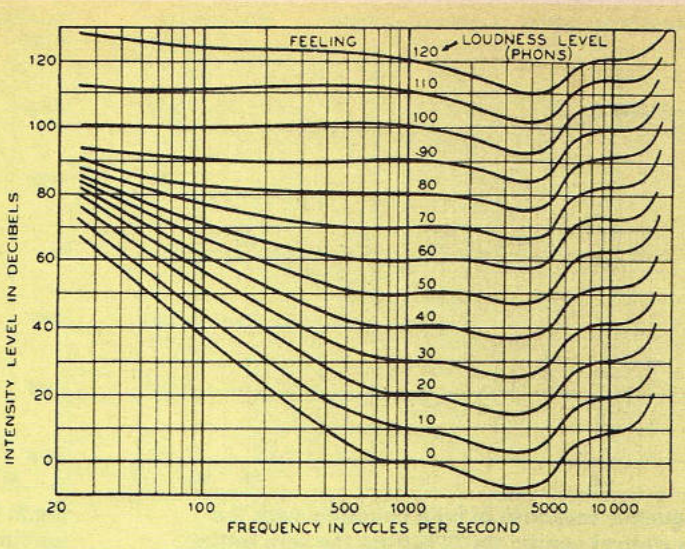


Fig.1: Fletcher & Munson "equal loudness curves" taken at sound levels from very soft (0dB) up to very loud (120dB). These curves demonstrate that our ears are far less sensitive to bass frequencies and somewhat less sensitive to treble as the sound level is reduced. Reproduced by courtesy of "Journal of the Acoustical Society of America".

Circuit details

Now let's talk about the circuit which is shown in Fig.7. This uses a TL074 quad FET-input op amp and not much else.

Looking at the left channel, the input signal is fed via a 0.15µF capacitor to IC1b which is connected as a unity gain buffer. This gives a high input impedance to prevent our circuit from unduly loading the program source and a low output impedance which we need to allow the loudness control to operate properly. The buffered outputs are fed via 10µF capacitors to the top of a 100kΩ ganged volume control, VR1a.

Ignoring the components associated

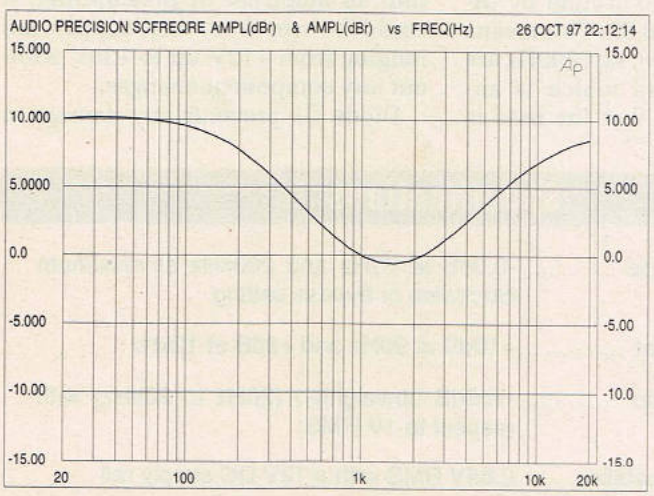


Fig:2: frequency response in both channels with the Loudness control wound up 25% from the zero setting.

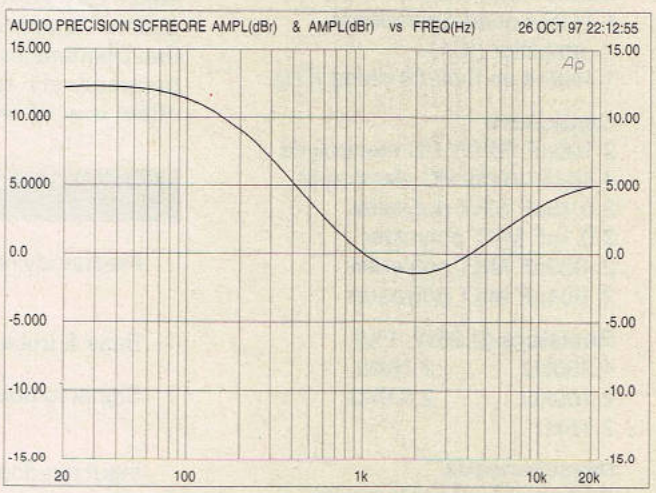


Fig:3: frequency response in both channels with the Loudness control wound up 50% from the zero setting.

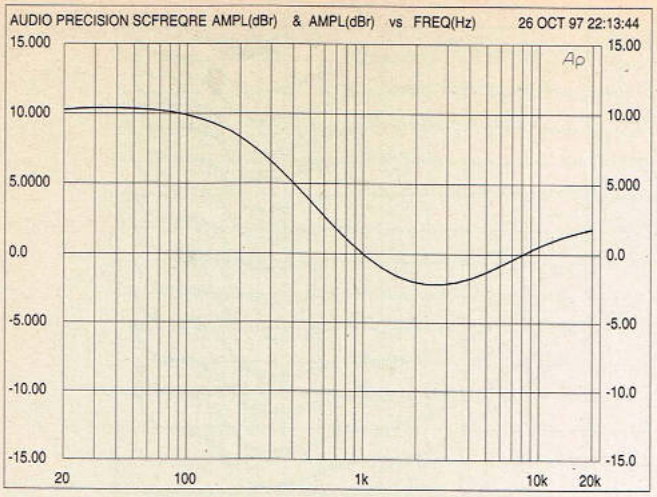


Fig.4: frequency response in both channels with the Loudness control wound up 75% from the zero setting.

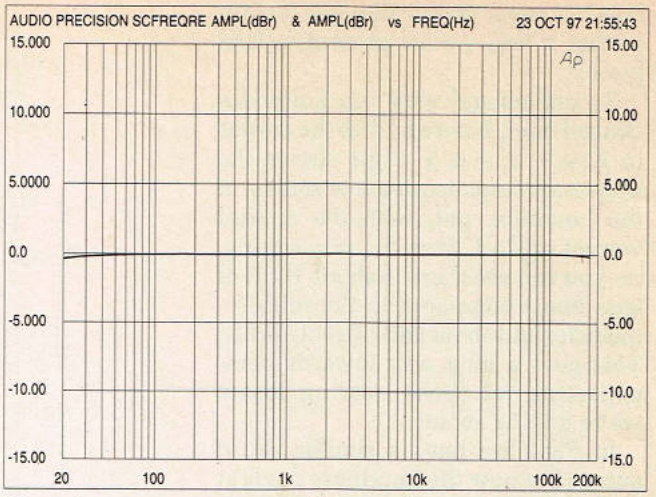


Fig.5: frequency response of the Loudness circuit at maximum gain or in the bypass setting.

with switch S1a for a moment, the signal from the wiper of VR1a is fed through a 0.1µF capacitor to the input of another unity gain buffer which feeds the output via an electrolytic capacitor. With S1a in the bypass setting, the frequency response is flat, as shown in Fig.5.

Note that the components associated with the bypass switch have no effect on the frequency response when S1a is in the bypass setting. Even though we effectively have two capacitors, .033µF & .001µF, and two resistors, 15kΩ & 3.9kΩ, in series across the 100kΩ potentiometer, they have negligible effect on the response because of the very low AC output impedance of the buffer stage IC1b.

But when the Loudness function is switched in, those four components across the potentiometer have a major effect, depending on the volume setting.

To explain how the boost works assume the volume control is set to mid-position. Now we see that the bottom half of the potentiometer is effectively shunted to ground by capacitor C2 and resistor R2. This means that frequencies above, say, 300Hz are progressively reduced which is another way of saying that the bass is progressively boosted. At the same time, the top half of the potentiometer is shunted by capacitor C1 and resistor R1. At the higher frequencies, say above 3kHz, the impedance of C1 will progressively reduce, allowing more high frequency signal to be fed from the top of the control to the wiper, giving treble boost.

This interaction between the boost components and the wiper position is quite complex, and as noted above, the amount of bass and treble boost is progressively reduced at higher settings of the volume control. We have selected component values which we feel give satisfying results without going overboard.

The circuit is powered from 12V DC which we assume will be from the battery in a car. Alternatively, if you wish to build the Loudness control into an amplifier or preamplifier, it could be run from any supply rail ranging from +12V up to +30V without any component changes.

Diode D1 prevents any damage to

Parts List

1 PC board, code 01111971, 102 x 46mm
1 plastic utility case, 127 x 68 x 42mm
1 100kΩ dual ganged linear potentiometer
1 knob to suit potentiometer
4 RCA chassis mount sockets
1 14 pin IC socket (optional)
12 PC stakes
2 6mm untapped spacers

Semiconductors
1 TL074 quad operational amplifier (IC1)
1 1N914 or 1N4004 diode (D1)

Capacitors
2 100µF 25VW PC electrolytic
4 10µF 16VW PC electrolytic
2 0.15µF MKT polyester
2 0.1µF MKT polyester
2 .033µF MKT polyester
2 .001µF MKT polyester

Resistors (0.25W, 1%)
4 330kΩ
2 100kΩ
2 15kΩ
2 10kΩ
2 3.9kΩ

Miscellaneous
Red and black hookup wire, solder.

Specifications

Frequency response	-0.3dB at 20Hz and 200kHz at maximum clockwise or bypass setting
Bass & treble boost	+10dB at 90Hz and +8dB at 12kHz
Signal to noise ratio	-106dB unweighted (20Hz to 20kHz) with respect to 1V RMS.
Input overload capability	2.85V RMS with a 12V DC supply rail
Total harmonic distortion	less than .003% at 1V RMS

the circuit if the supply voltage is connected the wrong way around.

Normally, an op amp such as the TL074 is used in a circuit with balanced supply rails, eg, ±15V. In this case, we split the incoming 12V supply with a voltage divider consisting of two 10kΩ resistors. This provides a 6V supply to bias the op amps and this is fed to their non-inverting inputs via 330kΩ resistors.

We should make one point about the dual-ganged potentiometer used in this project. Normally, volume control potentiometers have a logarithmic resistance/rotation characteristic but we have specified a linear pot. This has proved satisfactory and has a smooth and progressive action in this circuit. It also has the advantage of better matching between the two track sections.

Putting it together

We have assembled the Loudness Control into a plastic utility case measuring 127 x 68 x 42mm. This has the dual-ganged potentiometer and bypass switch at one end and the RCA input and output sockets at the other end. The PC board measures 102 x 46mm and is coded 01111971.

Some people may wish to delete the bypass switch and if this is so, the PC board may be mounted into an alternative case which is pictured elsewhere in this article.

The wiring diagram for the PC board is shown in Fig.8. Before assembling any components onto the PC board, check for any defects such as shorted or open-circuit tracks or undrilled holes. Make any necessary repairs before installing components.

Begin by fitting and soldering the three links, then the resistors and diode. Next fit the IC socket if you use one, followed by the PC stakes and the capacitors. Make sure that the electrolytic capacitors and diodes are installed the right way around. Then fit the potentiometer. We have made provision for conventional 25mm diameter pots or the small 16mm diameter type.

The wires for the inputs, outputs

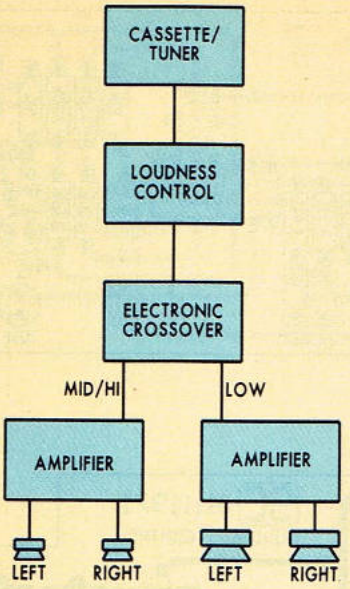


Fig.6: this shows how the Loudness control could be added into a typical car sound system. It is interposed between the cassette/tuner and the electronic crossover.

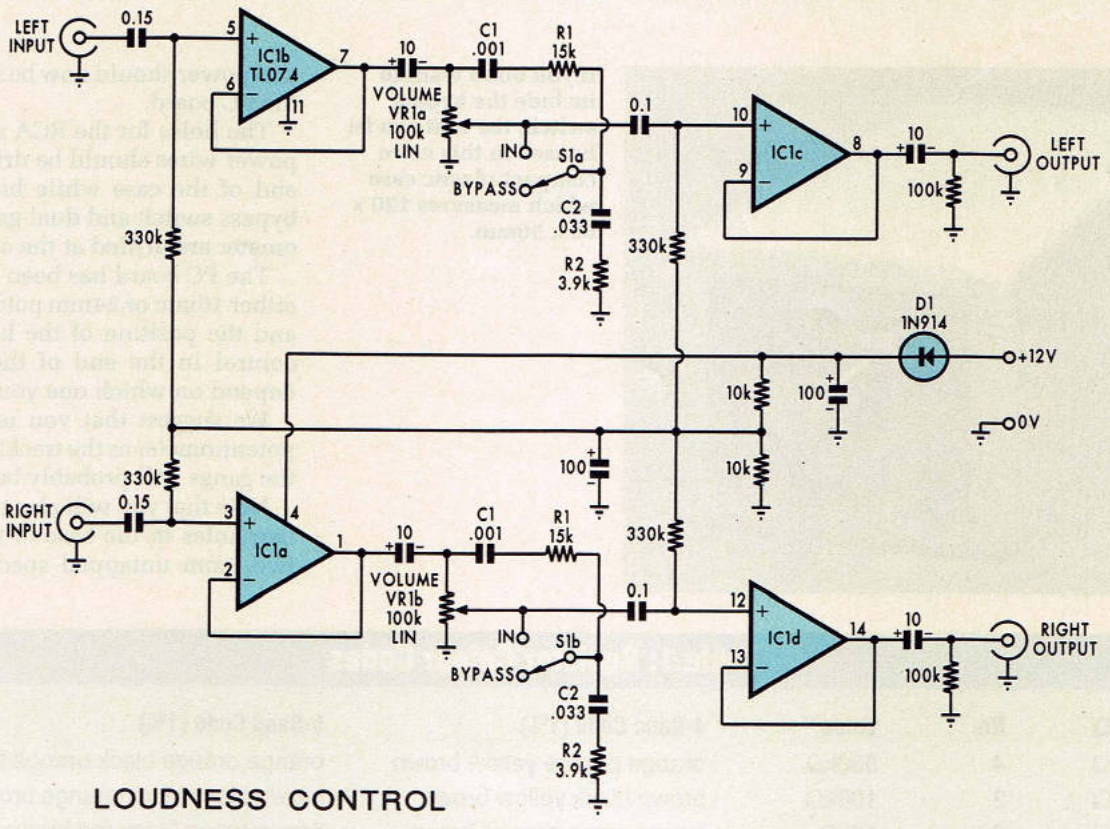


Fig.7: each channel of the circuit uses a FET-input op amp connected as a unity gain buffer. The loudness boost circuit itself is passive, reducing signal in the midrange to obtain bass and treble boost which varies with the control setting.

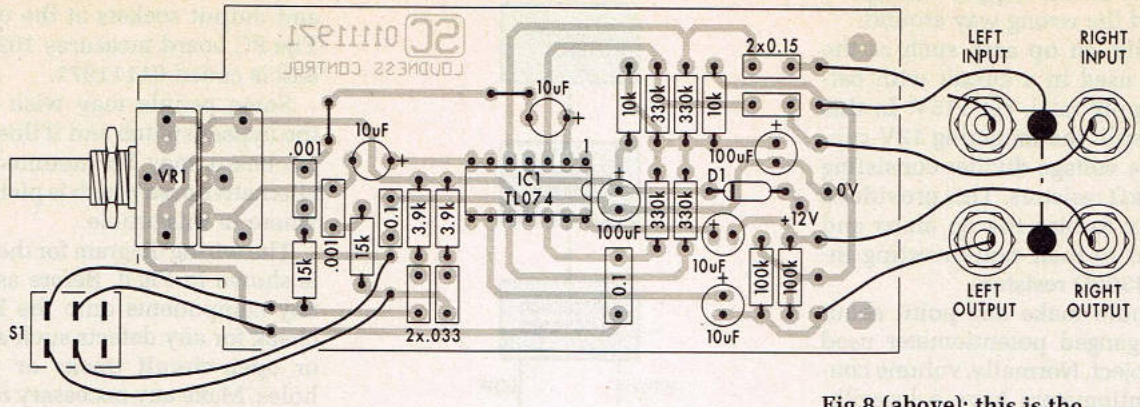


Fig.8 (above): this is the component layout and wiring diagram. Shielded cable is not required for the signal connections.

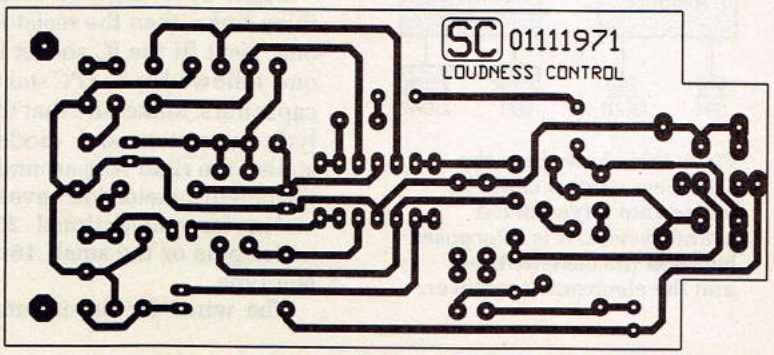
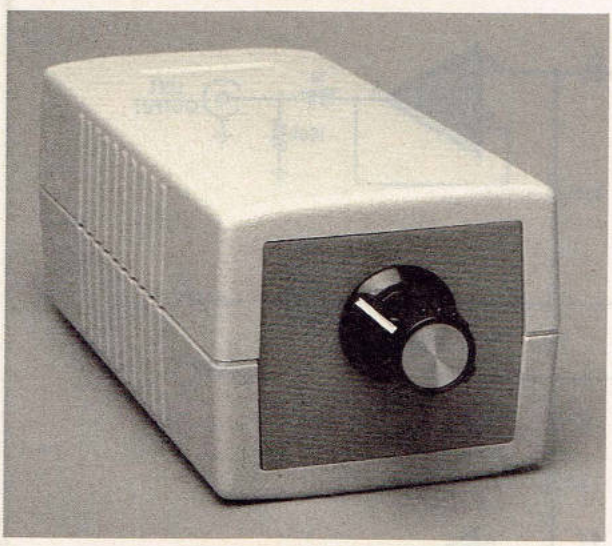


Fig.9 (left): actual size artwork for the PC board.



If you don't want to include the bypass switch, the unit can be housed in this more compact plastic case which measures 120 x 60 x 50mm.

and power should now be soldered on the PC board.

The holes for the RCA sockets and power wires should be drilled in one end of the case while holes for the bypass switch and dual-gang potentiometer are drilled at the other end.

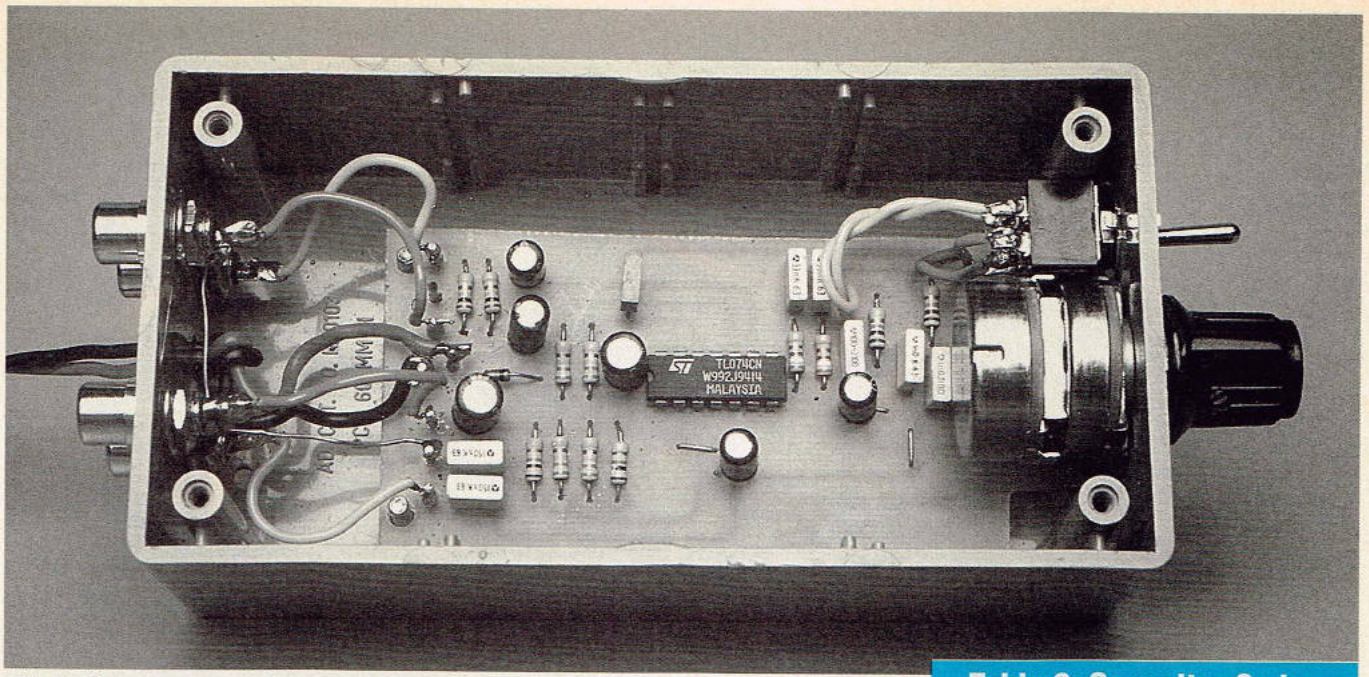
The PC board has been laid out for either 16mm or 24mm potentiometers and the position of the hole for this control in the end of the case will depend on which one you use.

We suggest that you use a 24mm potentiometer as the tracking between the gangs will probably be closer.

Note that you will also need to drill two holes in the base of the case for two 6mm untapped spacers to sup-

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	4	330kΩ	orange orange yellow brown	orange orange black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	2	3.9kΩ	orange white red brown	orange white black brown brown



The PC board is secured at one end by the pot terminals and at the other by 6mm standoffs and machine screws and nuts. The bypass switch can be considered optional – if you leave it out, the unit can be housed in the more compact case shown on the facing page.

port the PC board at the end opposite to the potentiometer.

Trying it out

To test the unit it will be necessary to connect it at the input to the power amplifier. Run your preamp leads to the input connectors and the amplifier input leads to the output connectors of the adaptor.

Rotate the Loudness control fully clockwise and then adjust the normal level controls on the system so that the volume is the loudest you are ever likely to want it. From now on, you use the Loudness control to adjust the playing level.

When you set the switch to the Bypass position you will notice that the overall sound level is higher but it will have less bass and slightly less treble. Now switch to the Loudness mode and you should immediately notice that the sound has more bass.

As you wind up the Loudness control to maximum setting, you should notice that while the sound becomes much louder, the bass does not become proportionately louder as well. This is as it should be because the amount of boost is progressively reduced as you wind up the level.

There will be times when the Loudness does not suit the program you are listening to and that is when you switch the Loudness mode off, using the Bypass switch. **SC**

Table 2: Capacitor Codes

❑ Value	IEC Code	EIA Code
❑ 0.15µF	150n	154
❑ 0.1µF	100n	104
❑ .033µF	33n	333
❑ .001µF	1n	102

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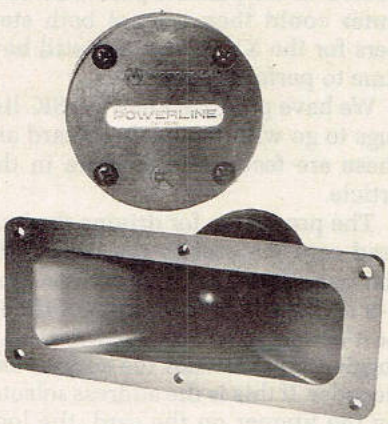

The new Powerline series of Motorola's 2kHz Horn speakers incorporate protection circuitry which allows them to be used safely with amplifiers rated as high as 400 watts. This results in a product that is practically blowout proof. Based upon extensive testing, Motorola is offering a 36 month money back guarantee on this product should it burn out.

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IMPORTING DISTRIBUTOR:
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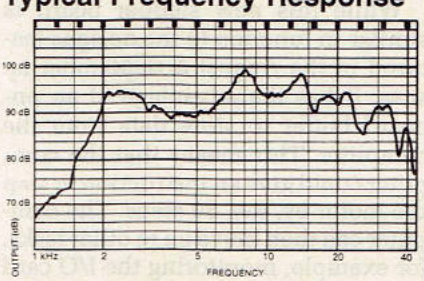
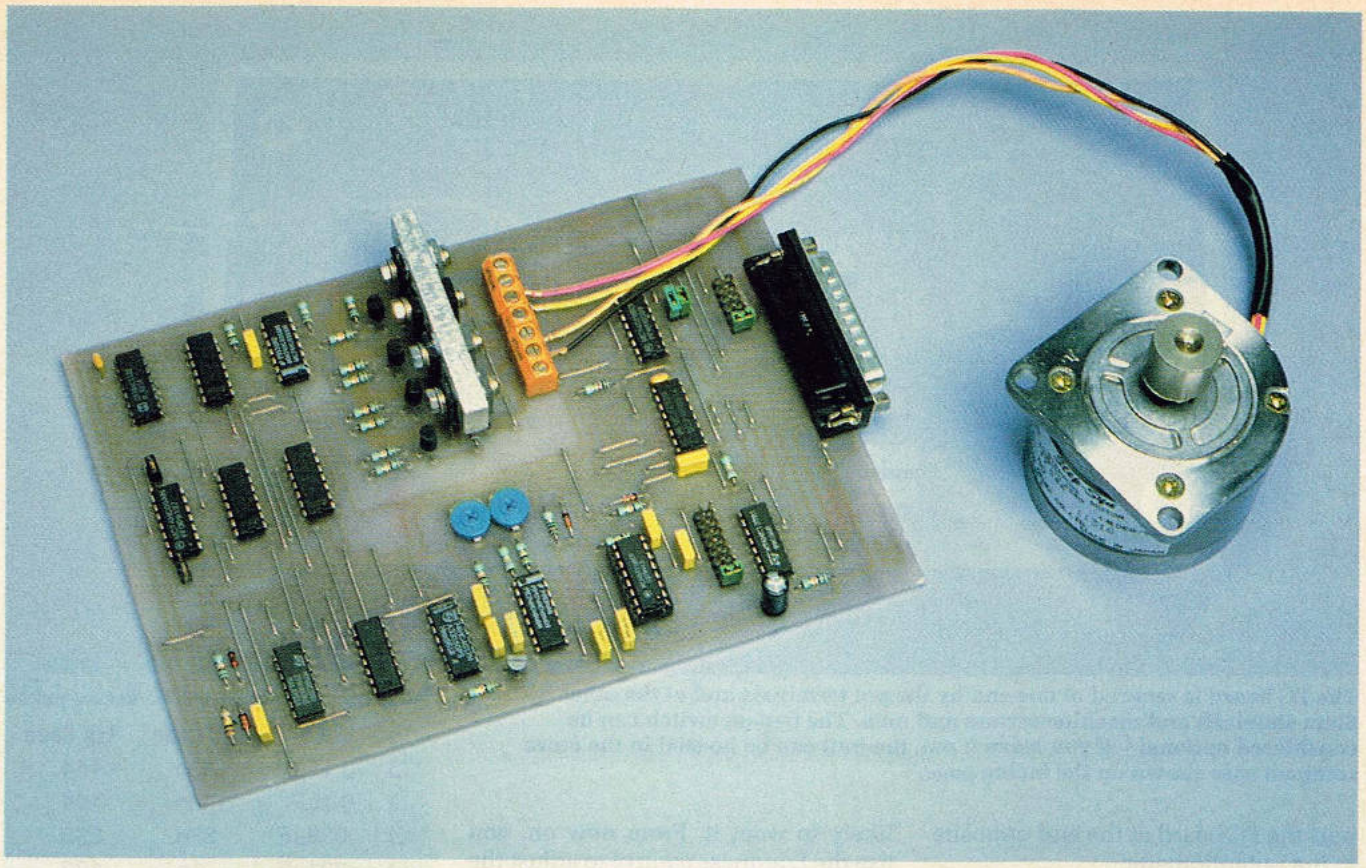
Frequency Response: 1.8kHz - 30kHz
Av. Sens: 92dB @ 1m/2.83v (1 watt @ 8Ω)
Max. Power Handling Capacity: 400W
Max. Temperature: 80°C
Typ. Imp: appears as a 0.3µF capacitor

Typical Frequency Response





Stepper motor driver with onboard buffer

This new buffered design stores the instructions for up to 63 revolutions and can be jumpered for forward or bidirectional stepping.

Design by RICK WALTERS

While this new stepper board is similar in function to the designs featured in the August & September issues, it has the advantage of an onboard buffer to store data from the computer. This means that the computer could give an instruction to step the motor by, say, 50 steps. The computer can then move on to other tasks, for example, monitoring the I/O card (described in July 1997) while the motor is stepping.

By contrast, the two previous designs required the computer to issue continuous instructions while the motors were being stepped; it could not perform any other function while a motor was stepping.

As with the previous designs, this new buffered stepper driver can be daisy-chained with seven others, either buffered or unbuffered. For example, if you wanted to produce an XY plotter, you could have two of these buffered stepper drivers connected to the parallel port. The computer could then control both steppers for the XY plotter and still have time to perform other tasks.

We have produced new BASIC listings to go with the buffered card and these are featured elsewhere in this article.

The procedure for driving the buffered card is virtually the same as for the unbuffered card: an address from 1-8 is placed on three pins of the PC port connector then the strobe line is toggled. This latches the address in a decoder. If this is the address selected by the jumper on the card, the logic

level present on the port's normal data lines is latched into the buffers. Once that happens the card takes over and the motor is stepped to the required position.

Jumper options

This buffered card is capable of driving the stepper motor in either forward or reverse direction. A jumper on the card selects forward only or bidirectional stepping. In forward only mode, using a 7.5 degree per step motor, up to 63 revolutions can be stored, in bidirectional mode the maximum is 32.

The motor begins stepping at a preset slow speed and accelerates to the preset maximum speed for that particular motor and supply voltage. When the motor is not stepping all the drivers are turned off, thus preventing the motor from overheating.

Another jumper selects full step or half step operation and provision is made via additional jumpers for the computer to interrogate the card(s) to determine whether it is still stepping or can accept another instruction.

Circuit details

Refer now to Fig.1 for the circuit details. While the overall operation of the circuit is quite complex it can be broken down into a number of simple blocks. The first of these is the card select logic which is carried out by IC1 and IC2.

IC1 is a 74HC137 three line to eight line active low latched decoder. This IC looks at the BCD address data on its A, B & C inputs and pulls the corresponding decimal output (Y0-Y7) low. However, this can only happen when the strobe line from inverter IC2a goes low and momentarily pulls the latch enable (LE) input of IC1 low via the series .001µF capacitor.

Step counter

Once the desired card has been selected, the number of steps the motor has to make is taken care of. This information will have been loaded into PortA and is present on the preset inputs (P0-P3) of step counters IC3 & IC4. The data is loaded into IC3 & IC4 by the action of pin 5 of IC2c going high (+5V) which takes the PL (parallel load) inputs of these two ICs high. Once there is any data present in the ICs, the TC pins (terminal count, pin 7) which were low will go high.

Parts List

1 PC board, code 07109971, 176 x 123mm
1 stepper motor, Oatley Electronics M25 or equivalent
1 25-pin PC mounting R/A "D" male connector
1 200kΩ PC mount trimpot (VR1)
1 500kΩ PC mount trimpot (VR2)

Semiconductors
1 74HC137 octal latch (IC1)
1 4572 complex gate (IC2)
2 4029 presettable counters (IC3,4)
1 74HC4046 phase locked loop (IC5)
1 74HC4017 decade counter (IC6)
1 74HC02 quad NOR gate (IC7)
1 74HC32 quad OR gate (IC8)
4 74HC4066 quad analog switch (IC9,10,13,14)
1 74HC00 quad NAND gate (IC11)
1 74HC112 dual JK flipflop (IC12)
4 BD681 NPN power transistors (Q3,Q4,Q9,Q10)
4 BD682 PNP power transistors (Q1,Q2,Q7,Q8)
4 BC548 NPN transistors (Q5,Q6,Q11,Q12)
1 2N7000 N channel IGFET (Q13)
4 1N914 signal diodes (D1,D2,D3,D4)

Capacitors
2 100µF 25VW electrolytic
2 0.1µF monolithic ceramic
4 0.1µF MKT polyester
2 .01µF MKT polyester
4 .001µF MKT polyester

Resistors (0.25W, 1%)
1 1MΩ
5 100kΩ
2 47kΩ
13 10kΩ
4 2.2kΩ
1 1kΩ

Miscellaneous
1 7-way terminal strip (5.08mm spacing)
1 8 x 2 pin strip
1 5 x 2 pin strip
1 2 x 2 pin strip
2 2-pin strips
5 jumpers for above
1 58 x 6 x 12mm aluminium bar
4 3mm x 16mm bolts
4 3mm nut
8 3mm flat washer
4 3mm star washer
8 TO-220 insulating washers

This has two outcomes: the output of OR gate IC8b (pin 6) will go high and via D4, it will rapidly turn on the CMOS switches IC13 and IC14, allowing pulses to reach the stepper motor coils, MA & MB. We'll come back to describe how MA & MB are driven later in this article.

This high level from pin 6 of IC8b is inverted by IC2e and the inhibit pin of IC5 (pin 5) which was held high now goes low. This allows the VCO (voltage controlled oscillator) in this chip to start. The oscillator output at pin 4 is a square wave which begins clocking decade counter IC6.

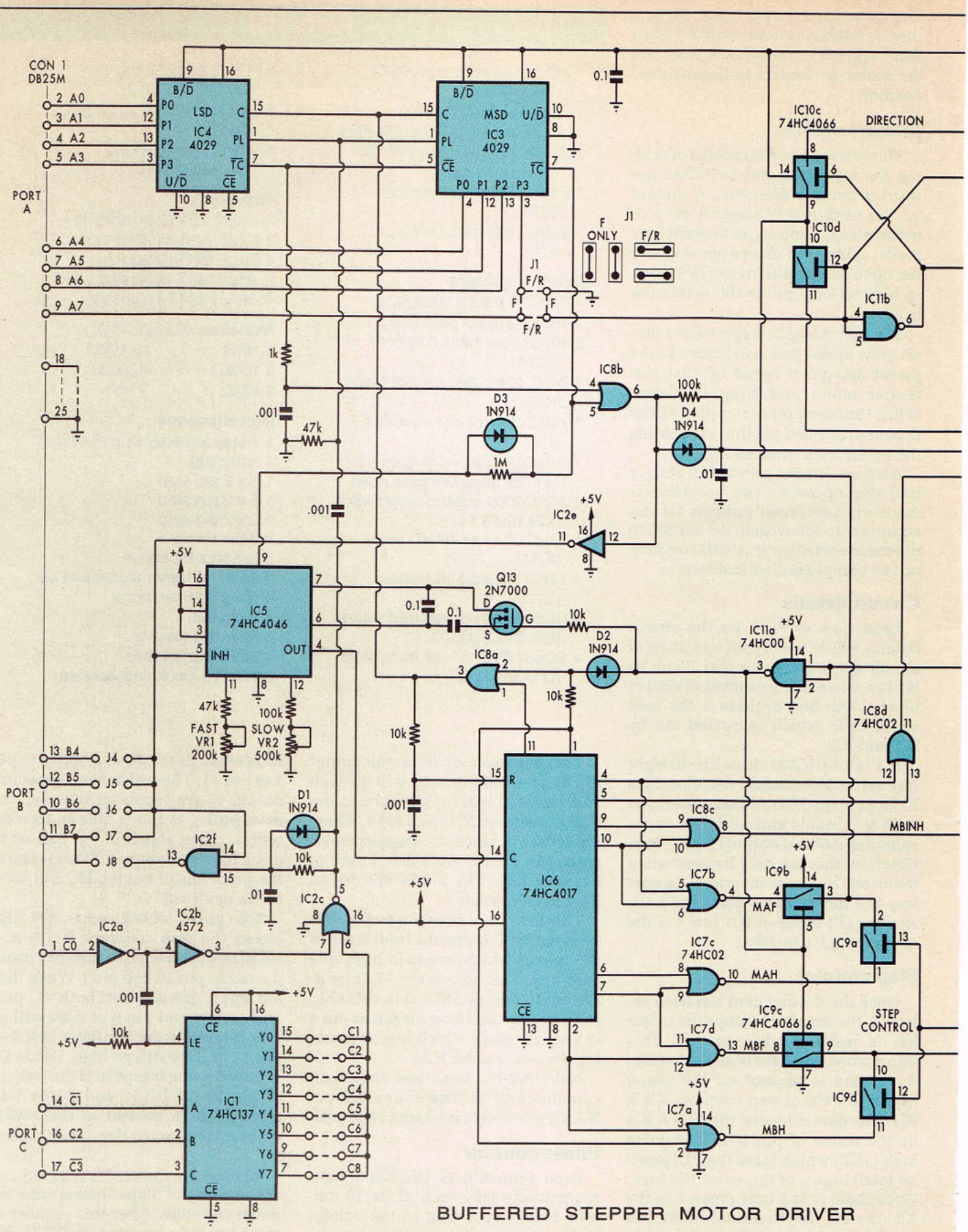
Note that IC2 is an odd chip, as it contains four inverters, one 2-input NAND gate and one 2-input NOR gate.

Phase counter

Each time IC6 is clocked it will sequentially take each of its 10 outputs high. Depending on the voltage at the cathode of D2, it will be reset by IC8a when its output is stepped to pin 1 or pin 11. The resistor and capacitor on pin 15 are necessary to widen the reset pulse, as IC6 is able to be reset with a pulse which is too narrow to clock the step counters. (This is one of the problems of mixing HC and 4000 series devices.)

The pulse which resets IC6 also clocks the step counters, IC3 & IC4, which are connected so that they count down (ie, pin 10 tied low). When they are empty (zero count) both TC pins will go low and pin 6 of IC8b will go low, inhibiting the oscillator in IC5 as pin 11 of IC2e will go high. Diode D4 is now reverse biased and the voltage at pin 13 of IC13a and IC14a will slowly fall to ground as the 100kΩ resistor discharges the .01µF capacitor.

So to recap, the card is selected and the number of steps loaded into the down counters. After this number of steps has been counted, the VCO will


CON 1
DB25M
PORT A
PORT B
PORT C
IC4 4029 LSD
IC3 4029 MSD
IC5 74HC4046
IC6 74HC4017
IC1 74HC137
IC2a
IC2b 4572
IC2c
IC2e
IC2f
IC7a
IC7b
IC7c 74HC02
IC7d
IC8a
IC8b
IC8c
IC8d 74HC02
IC9a
IC9b
IC9c 74HC4066
IC10c 74HC4066
IC10d
IC11a 74HC00
IC11b
DIRECTION
F ONLY
F/R
J1
D1 IN914
D2 IN914
D3 IN914
D4 IN914
Q13 2N7000
FAST VR1 200k
SLOW VR2 500k
MAF
MAH
MBF
MBH
MBINH
STEP CONTROL
+5V
BUFFERED STEPPER MOTOR DRIVER

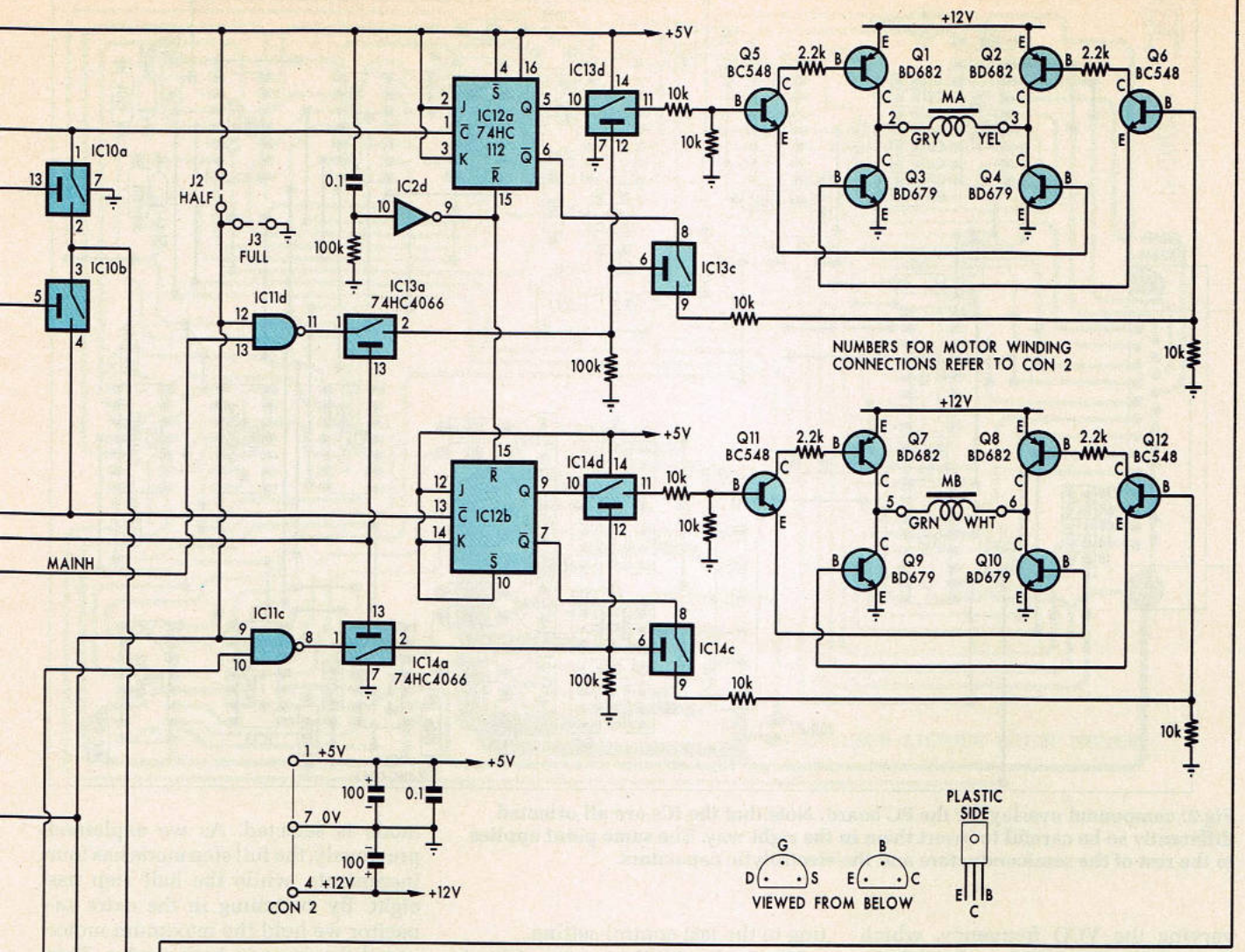


Fig.1: presettable up/ down counters IC3 & IC4 form a buffer for data from the computer's printer port. This lets the computer download steps and it can then perform other functions while the motor is stepping through.

be inhibited and will stop driving the phase counter. The logic signals to the stepper motor transistors will also be turned off, preventing any current flow in phase windings MA and MB.

Full step - half step

If you have looked at the driver software for the previous stepper motor cards you may have observed that for a full step, four sub-steps are used, but for half steps eight are needed. The same situation applies in this case (refer Table 3).

A jumper across J3 sets the full step condition. This pulls pins 1 & 2 of IC11a low which results in the cathode of diode D2 being pulled high. This resets the phase counter (IC6) and the step counters are now clocked by IC8a when pin 1 of IC6 goes high; ie, after four steps.

For the half step mode, a jumper across J2 pulls pins 1 & 2 of IC11 high, which holds diode D2's cathode low, preventing pin 1 from resetting the counter. IC6 will be reset and will also clock IC3 and IC4 when it reaches a count of nine; ie, when pin 11 goes high, after eight steps.

Speed ramp up

Before we look at all the gates connected to the outputs of IC6, we should discuss the operation of the VCO, in IC5. It starts the motor stepping at a slow speed, as set by VR2, and gradually increases the stepper rate to a value dictated by the fast control VR1. This is done because a stepper motor will ramp up to a higher speed than it will start from, due to the inertia of the rotor.

We achieve this speed increase by

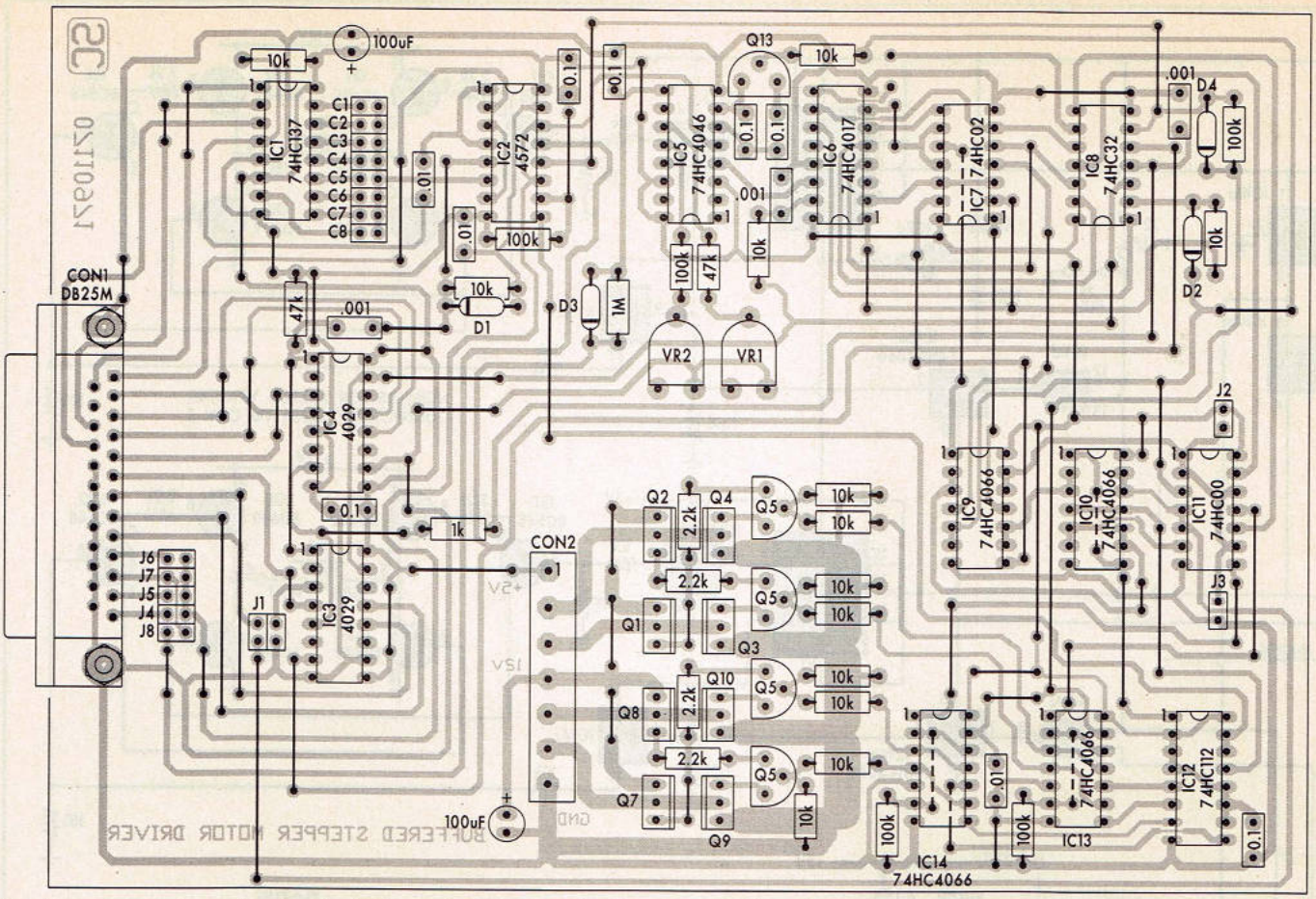


Fig.2: component overlay for the PC board. Note that the ICs are all oriented differently so be careful to insert them in the right way. The same point applies to the rest of the semiconductors and the electrolytic capacitors.

varying the VCO frequency, which depends on two factors, the voltage on pin 9 and the resistance from pins 11 & 12 to ground. When pin 9 is low, the output frequency is set by VR2 (set slow), and when pin 9 is taken to +5V, the output frequency is dictated by VR1.

By charging the 0.1µF capacitor through the 1MΩ resistor, the voltage on pin 9 slowly increases from zero to 5V and consequently the motor speed increases from the slow control setting to the fast control setting.

When the MSD counter, IC3, is empty its TC output will swing low and rapidly pull pin 9 of IC5 low, by courtesy of diode D3. This will immediately reduce the motor speed to SLOW for any counts remaining in IC4. The filter network on pin 7 of IC4 is used, as one of the data books claims that glitches can be present at this output.

Mosfet Q13 switches an additional capacitor in circuit when the full step mode is selected. As we explained previously, the full step mode has four increments, while the half step has eight. By switching in the extra capacitor we hold the maximum motor speed the same in both modes. This allows a card to have its trimpots initially set for a particular type of motor, allowing it to run in either mode without any readjustment to the presets.

Decoder

The outputs of IC6 are fed to seven gates which are used to decode and direct the logic levels to the appropriate points. The explanation of how this is done is too involved to go into

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	5	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	13	10kΩ	brown black orange brown	brown black black red brown
❑	4	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
0.1µF	100n	104
.01µF	10n	103
.001µF	1n0	102

in detail. Table 3 explains the logic sequence used to drive the stepper in each mode. By using this table you will be able to trace out the logic paths if you wish.

Step control

The quad analog switch package IC9 is labelled as the step control. It switches either IC7a & IC7c or IC7b & IC7d to the inputs of IC10, the Direction switch. If the jumper is placed on J3 (FULL) the signals MAF and MBF from pins 4 & 13 of IC7 are fed to IC10. If J2 is selected (HALF), then MAH and MBH from pins 1 & 10 of IC7 are the selected signals. Also IC11c and IC11d, which are disabled in the FULL mode, will be able to pass the MA_{INH} and MB_{INH} signals from pins 8 & 11 of IC8 to IC13 and IC14. When these ICs are turned off the zero current in Table 3 is achieved.

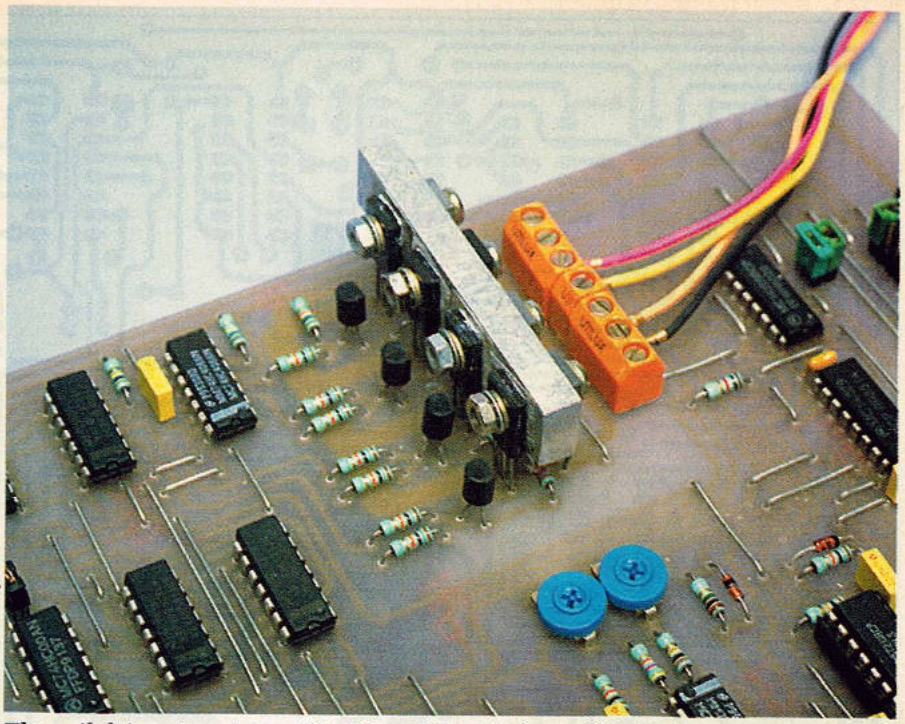
Motor direction

If F/R (forward-reverse) is selected with jumper J1, then the logic level on A7 of PortA (pin 9) will control the direction. If it is high, IC10 will be switched and the motor will step backwards. What this IC does is to swap the pairs of gates (from IC7 which are selected by IC9) to the inputs of IC12.

IC2d is used as a power-on reset to ensure that both flipflops of IC12 are reset at turn on. Each time an input of IC12 (pins 1 & 13) goes low the logic levels on the outputs change. The outputs of IC12a are fed through IC13 to drive motor coil MA and the outputs of IC12b are fed through IC14 to drive coil MB.

Winding control

The path through IC13 (and IC14) is actually two switches in series. As we have explained previously, when IC8b's output is high one switch is on and this will allow the coils to be energised. The outputs of IC8d & IC8c (MA_{INH} and MB_{INH}) will switch off the drive signals through IC13 and IC14 when a zero is needed in the half step table. In the full step mode, IC11c and IC11d will have one input low (J3) and their outputs will always be high, keeping that switch turned on.



The coil driver transistors (Q1-Q4 and Q7-Q10) are all bolted to a common aluminium heatsink to aid heat dissipation. Note that the transistors must all be isolated from the heatsink using insulating washers.

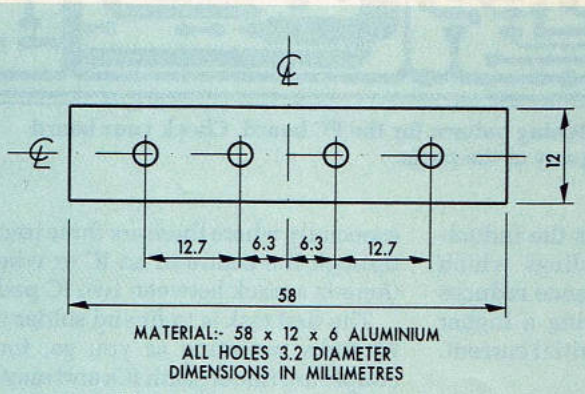


Fig.3 drilling details for the aluminium bar heatsink.

Coil driver

Transistors Q1-Q12 make up two H-bridge circuits which drive the stepper motor coils, MA & MB. These circuits are identical so we will only describe the circuit based on Q1-Q6 which drives MA. This top circuit is driven from the Q and Q-bar outputs of IC12a, via switches IC13d and IC13c.

Consider the situation when Q is high and Q-bar (of IC12a) is low. Q5 will turn on and this will also turn on Q1 & Q4. As a result, current flows through Q1, coil MA and Q4. Conversely, when Q-bar of IC12a is high, transistors Q6, Q2 & Q3 turn on, causing current to flow through coil MA in the opposite direction.

If IC13 is turned off, then both Q5 & Q6 will be off and no current will flow through coil MA.

Almost all motors, including the centre-tapped 5V types (as we don't use the CT) can be powered from the 12V supply. If you want more torque and a faster stepping speed you can run a motor from a higher voltage but you should include a series resistor in each coil to keep the motor current

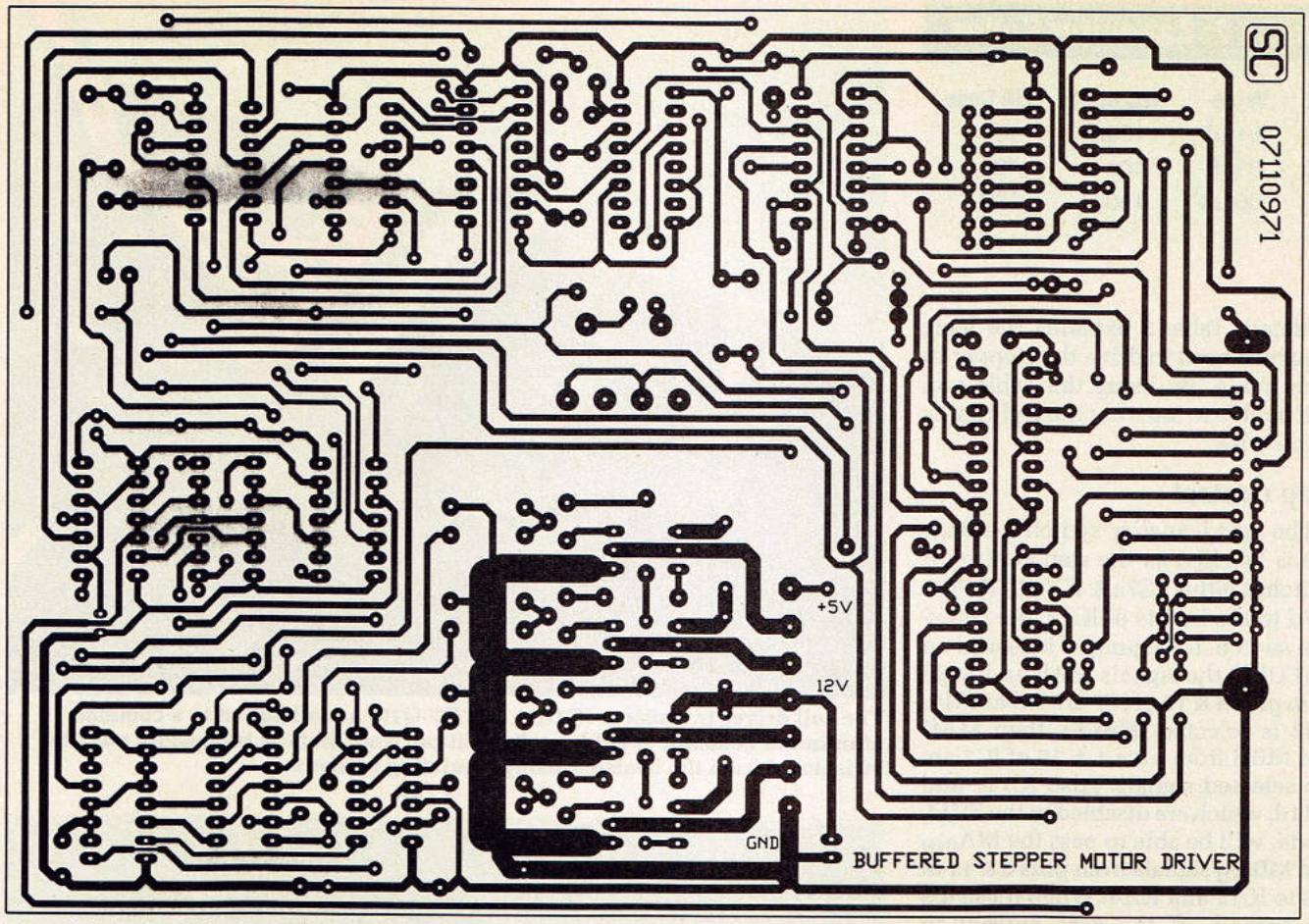
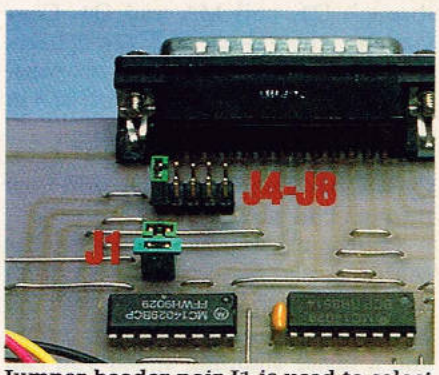


Fig.4 this is the full-size etching pattern for the PC board. Check your board carefully before installing any of the parts.

within specification. It is the inductance of the motor windings which limits the current and hence reduces the torque, so by applying a higher voltage we get a higher initial current.

Building the board

Before you begin the board assembly it is worthwhile checking the copper pattern against the artwork of Fig.4,



Jumper header pair J1 is used to select forward or forward/reverse (shown), while jumpers J4-J8 provide the card with a unique identification.

especially where there are three tracks through the centre of an IC or where there is a track between two IC pads.

The first task is to fit and solder the 72 links, counting as you go, for a couple are underneath ICs and may be difficult to install later on. Next fit and solder the resistors and diodes, then the ICs. Continue with the trimpots, jumper strips and capacitors.

It is advisable to bolt the eight power transistors to a common heatsink if you intend driving high current stepper motors for long periods. The heatsink fitted to the prototype was a piece of aluminium bar 12 x 6 x 58mm long.

Fig.3 shows the drilling details for the heatsink. The best procedure is to loosely attach all the transistors to the heatsink bar and then mount the entire assembly on the PC board. Be sure to use insulating washers to isolate the metal faces of the transistors from the heatsink. The BD682 PNP transistors are all mounted on one side of the heatsink while the BD679 NPN types mount on the other side.

Table 3

Full Step (Both Windings Energised)

Step	MA	MB
1	L-R	L-R
2	R-L	L-R
3	R-L	R-L
4	L-R	R-L

Half Step

Step	MA	MB
1	L-R	L-R
2	0	L-R
3	R-L	L-R
4	R-L	0
5	R-L	R-L
6	0	R-L
7	L-R	R-L
8	L-R	0

Once the heatsink assembly is in position, solder one lead at either end and then tighten all the mounting bolts. The assembly can then be adjusted to sit parallel to the PC board and the remaining transistor leads soldered.

After you have finished, check the copper side of the PC board for any

Listing 1

```
10 PORTA = &H378 'this is LPT1 use &H278 for LPT2
20 PORTB = PORTA + 1: PORTC = PORTA + 2
30 OUT PORTA,20: OUT PORTC,11 'set 20 steps and card 1
40 OUT PORTC,10 'reset strobe
```

The following code will allow you to identify which cards are busy. You must run it after the previous code or redefine the ports (lines 10 & 20)

```
100 OUT PORTC,11 'select ANY active card
110 OUT PORTB,120 'set PORT B lines high
120 B = 127 - INP(PORTB) 'read PORT B lines
130 IF B AND -128 THEN J7$ = "J7 busy "
140 IF B AND 64 THEN J6$ = "J6 busy "
150 IF B AND 32 THEN J5$ = "J5 busy "
160 IF B AND 16 THEN J4$ = "J4 busy "
170 PRINT J7$ + J6$ + J5$ + J4$
180 WHILE B>0 OR B<0: B = 127 - INP(PORTB): WEND 'wait for all cards
190 OUT PORTC,10 'reset strobe
200 PRINT "All motors stopped."
210 END
```

Table 4

Jumper	Code
J4	16
J5	32
J6	64
J7	128

unsoldered pads which can mean missing components or links.

Finally, complete the assembly by fitting the 8-pin header, the DB25 connector and the 7-way terminal block.

Testing the board

Before you apply power to the card, turn both trimpots anticlockwise, fit the jumper to select card 1 (C1), fit J3 and fit the two F/R links so that they are parallel to Con1. You will need a 25-way D male to female cable to connect the card to the computer's parallel printer port.

You will also need a power supply capable of supplying 5V at a few milliamps and 12V at probably around 1A, to supply the stepper motor.

The first four lines of Basic code in Listing 1 will allow you to test the card.

PortB jumpers

The major advantage of this card is that the computer can send the number of steps for the motor to make, then do something else while the card is driving the stepper. We now need some way of letting the computer know when the job is completed.

Two different methods are available on this card. If one or several of them are being used in a system, jumpers J4-J7 can be used. The STOP line on each card is low while the motor is running and goes high when the motor stops. If each card uses a different jumper the computer can read PortB and determine the status of the cards (see Table 4).

If only one card is in use, J8 can be used but only if the card is left selected. In this case the line is high while the motor is stepping and goes low when the motor stops. As this input line is inverted the program will see the inverse of this logic. **SC**

How To Get The Software

All the software for this series of stepper cards and the I/O card described in the July 1997 issue is now available on a 3.5-inch floppy disc for $7 plus $3 postage and packing. Payment may be made by cheque, postal money order or credit card (Bankcard, Visa or Mastercard) to Silicon Chip, PO Box 139, Collaroy, NSW 2097 or via fax (02) 9979 6503.

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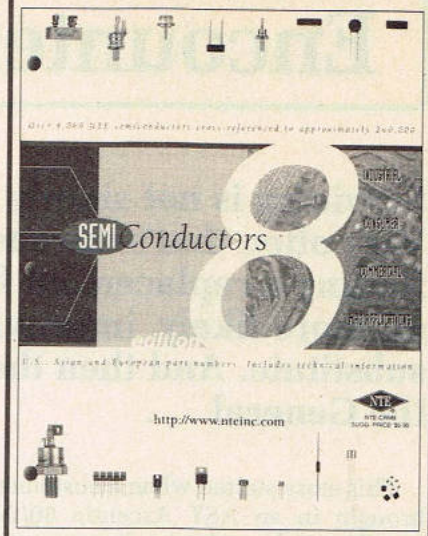

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SERVICEMAN'S LOG

Encounters with a notebook PC

Servicing is not simply a matter of fault finding. Very often that's the easy part; the hard part is finding a replacement for the faulty component or, more likely, improvising an adequate substitute. And then there was the Colonel and the General . . .

This story started when a customer brought in an AST Ascentia 800N 486SX33 Colour Notebook computer, plaintively complaining that, "it simply just stopped. And could you fix it ASAP?" And he wanted a free quote.

In greater detail, the unit was about three years old and now out of warranty. Which is fair enough but there is still the worry about spare parts availability. And at a practical level I have worked on a few notebooks and learnt there is nothing cheap or easy about fixing them.

I asked him whether it had been dropped or otherwise abused and he assured me it hadn't. I switched it on in front of him and noticed that various LEDs were flickering and hard disc noises were emanating from inside, suggesting it was trying to boot. But there was no trace of any image.

I wasn't prepared to spend any more free time in diagnosing this, other than to simply guess that his colour LCD display was U/S and would probably be very expensive to replace.

The customer wasn't too happy with this but eventually agreed to pay for an in-depth cost estimate of repairing the unit (say one hour's worth at least, anyway). But I made it clear that this may still leave him where he was now. He said he would chance that.

I set aside an hour that afternoon and my first step was to connect an external monitor to it. This was easy enough, using the outlet socket provided. But making the monitor function was another matter. All I got was a momentary flash on the screen and nothing more.

Fortunately, he had brought in the operating manual. This nominated how to combine the Fn (function) and Esc keys to present the video setup menus; except that there was no way to display these menus in order to find out how to display them (catch 22!). But the manual did indicate how to toggle between the internal LCD and an external monitor, using the Fn and F12 keys.

I also noticed that this notebook had no conventional brightness and contrast controls. Changing these functions involved operating the Fn and arrow keys.

I switched on and tried all these suggestions but, apart from the momentary flash on the external monitor, nothing was happening. However, I persevered until finally, after it had been booting for a few minutes, the Fn and F12 keys caused the external monitor to flash on with a useful image.

The reason why this hadn't happened at switch-on, I surmise, was because the processor was initially fully engaged with booting up and was unable to accept commands from the keyboard. Now I could at least display the video setup menu for the LCD and the CRT display and check the computer itself, which now booted OK.

At least I had now confirmed that the motherboard and the other basic hardware devices were working, narrowing the fault to the display. It was possible that the LCD driver stages in the video section were faulty but this was not very likely. And that left the LCD itself, the power supplies to it and, possibly, the brightness and contrast control circuits.

Getting inside

So now I had to get inside the device. The only way to do this is to disassemble the lid assembly which isn't too easy. I had to find two vital screws and, to do so, prise off two concealed glued covers near the hinges. Next, one has to remove the clip-on hinge covers before – very carefully – unclipping a plastic mask around the edge of the upper top lid assembly.

This all involves a high risk of marking the soft plastic and breaking the clips. However, once inside I could see a small PC board about 15 x 50mm which I quickly established as a miniature switchmode power supply for the backlight tube.

By removing three more screws, the metalwork, plastic sleeving and the board could be removed. The board had two sockets on it, one at each end. One connected a 2-pin lead to the backlight and the other was a 4-pin input supplying power and data. More than that I could only guess at without acquiring a circuit and there was little hope of that at short notice.

Examining the board, I noticed a small 1A "Pico" fuse (these are moulded devices, similar in appearance to a 0.5W resistor and soldered directly into the board). It was near the input socket, and the ohmmeter quickly confirmed that it was open. I worked out that pins 1 and 4 were the 12V battery input, pin 1 being common. Unfortunately, replacing the fuse caused it to blow immediately though there was no obvious short circuit.

Most probably, this was the problem area and the easiest solution would be to replace this board. Mrs Serviceman was enlisted to track one down, which she enthusiastically proceeded to do. However, one week later and totally dispirited with broken

promises of phone and fax backs, she finally established that this part was unavailable. The best offer was a complete display unit at $522.15, plus tax, plus freight plus six weeks delivery.

I telephoned the customer with the bad news and his response was to ask whether I could actually repair the board. I pointed out that the multilayered board contained several ICs, all the components were surface mounted, and I couldn't identify many of them. And if the transformer had shorted turns, there would be no hope.

However, I very hastily added, I might be able to fix it. My ego was exceeded only by my stupidity. "Look", he said, "if you can fix it for $300, go ahead; otherwise you can have it for parts in lieu of service charges due so far". What a challenge!

Three-layer board

With a three-layer PC board and about 20 SMDs (surface mounted devices), it was going to be very difficult to work out the circuit. And there were no visual clues to show where there was a short circuit.

As a starting point, I decided to connect an ammeter across the blown 1A fuse and see what current was actually being drawn. This turned out, in a round about sort of way, to be the best thing I could have done. Before I could even change the range on the multimeter, smoke appeared from under a large 3-terminal active power device – probably an SCR. It was bent over parallel to the board and bending it upright revealed two surface mounted transistors and two surface mounted capacitors. And one of each of these devices was cooked.

The overloaded transistor was marked R25A (only just visible under the burnt case) and the capacitor had no markings at all. It looked like a ceramic. I could read no short circuit on either component, in circuit, and as the capacitor was connected to the transistor's collector, I thought the best course was to remove the capacitor and see what happened.

Unfortunately, in the process of desoldering it, the capacitor disintegrated, leaving a black patch underneath. I soldered another Pico fuse in and switched on – not expecting much progress. But I was delightfully surprised to see the screen light up and data appear.

Delirious with happiness, I cleaned up the black spot, reassembled everything and put it aside to test. Everything continued to work OK until I switched it off at the end of the day and noticed that the screen was still alight, although there was no image. There was no time left to do anything about it except disconnect the battery.

I thought about it overnight and concluded that the burnt transistor must be damaged and would need to be replaced. The next day I measured the transistor again, in circuit, on the x1 ohmmeter range and it read OK (it turned out to be a PNP transistor).

However, when I removed it from the board and checked it on the x10,000 range, it measured quite leaky.

I was now faced with the problem of finding a replacement and I couldn't find any mention of the R25A in any of my equivalents books or software.

Surface mounted components are not normally considered serviceable and only manufacturers keep specifications. As they have been around for approximately 10 years, the standards for the alphanumeric characters printed on them have changed.

I found an early Sharp VR service manual with a section on SMDs using only 2-digit alphanumerics to identify them but this didn't help with a 1994 4-digit identifier. My educated guess was that it might be equivalent to a Toshiba 2SA1204 using an X12B case but in any event where would I get one of these?

A little lateral thinking led to a scrapped Marantz audio cassette player which used SMDs, and for which I had an excellent service manual. From this, I spent some time looking for the most powerful device used in the power supply circuits with the same case package.

Having identified the most likely one, I transplanted it into the power supply and reconnected everything. This time everything worked perfectly. All that remained was to run Scandisk and other utilities to clean up the hard disk.

Both the customer and I were happy with the outcome. The ceramic capacitor would probably have had a value of anywhere up to .001µF but because there was no room over the burnt area, I couldn't fit a replacement. I was not able to locate the actual cause of the problem as the capacitor had disintegrated on removal.

Precision walking

My next story is long way from notebooks. It involves a regular lady customer; kindly, energetic and euphemistically described as "stocky". But with six offspring to control, she doesn't take any nonsense.

How she and the 52cm TV set she was carrying both fitted through the door was an exercise in precision walking – there was barely a 1mm clearance on either side. She plonked the set on the counter, informing us that it was dead. She also added that if it turned out that one of the kids had done it, she wanted to know. This sort of lady commands respect, if you know what I mean!

The set was an Akai CT2007A and was made in China. It was not very old but obviously was rarely, if ever, switched off. The remote control wasn't supplied with the set but I wasn't going to ask any questions about that.

The circuit of this set is similar to so many different brands and models that

I had a pretty good idea of where to look first. It was no real surprise to find that C917 (100µF) on the main HT line (115V) was about to expire and that R918 (0.68Ω) on the 18V rail was open circuit.

I also automatically replaced two 47µF electros (C909 & C911) in the switchmode power supply before going for 12V zener diode ZD401 which was shorted. It also took out the 1A Pico fuse (F401) supplying it.

I felt fairly sure I had everything right before switching it on – but nothing happened. A voltage check cleared the 115V rail but the 18V rail was low. At that moment I didn't put too much significance on this, which was a mistake. The most obvious symptom was the failure of relay RLY901 to activate. This switches the set on and off and is driven by transistor Q905.

Q905 is in turn driven by Q621, then by Q605, and this is fed from pin 15 of the CPU (IC801). I suspected some sort of control problem from this CPU. By using the ohmmeter on the x1 range, with the black lead as active, I could bias Q605 on and the set fired up, giving a good picture but no sound.

This last observation was the breakthrough. There was loss of sound, a low 18V rail and now another indicator: R922 was overheating. This feeds Q905 and then pin 2 of IC201, the TDA1904 sound output IC. All of which threw suspicion on this IC. Sure enough, replacing the TDA1904 not only allowed the set to switch on correctly but also restored the sound.

I was pleased to timidly report to the customer that the kids probably hadn't done anything wrong – except perhaps watch too much TV!

The Colonel's General

When Colonel Jones came into the shop, mumbling about something wrong with the General in the back of his car, there was some confusion at first. But I quickly realised that he was referring to a TV set rather than to his military superior.

Some models stand out among the early colour TV sets sold in Australia and General was one. General made its reputation with cheap, reliable sets that performed well. And the Colonel's 1980 GC161, a 42cm portable, is one of which I am quite fond.

The Colonel's General was quite dead but the Colonel assured me that it would sometimes come on. The first fiddly bit with all these portables is removing and replacing the back, as the telescopic aerials always get in the way. There is also the problem of aligning the chassis with the rear and front shells and the front control knobs.

Because their reliability has kept them in the field for so long, most of my colleagues have acquired considerable skill and experience in dealing with them. They know just where to go to find the most common faults. And the Colonel's General provided an opportunity to recall some of these.

The first line of attack is to solder the dry joints on the motherboard, particularly along the edge connectors of the various modules and on the horizontal drive transformer T602, pin cushion transformer T603, and the horizontal linearity coil L608. Then the modules themselves need reworking, especially the power supply.

In this instance, none of this fixed the problem but when I measured the three power supply voltage rails, I found that the 15V rail was down to less than 10V. Replacing C642 (47µF 25V) fixed the problem and restored the sound and picture.

This capacitor can also cause lack of height, no colour and a dark picture with low sound, depending on what stage of failure it has reached. If the power supply pulsates, the culprit is invariably the X807 (CV12B) overvoltage protector and one would be advised to replace all the electros in

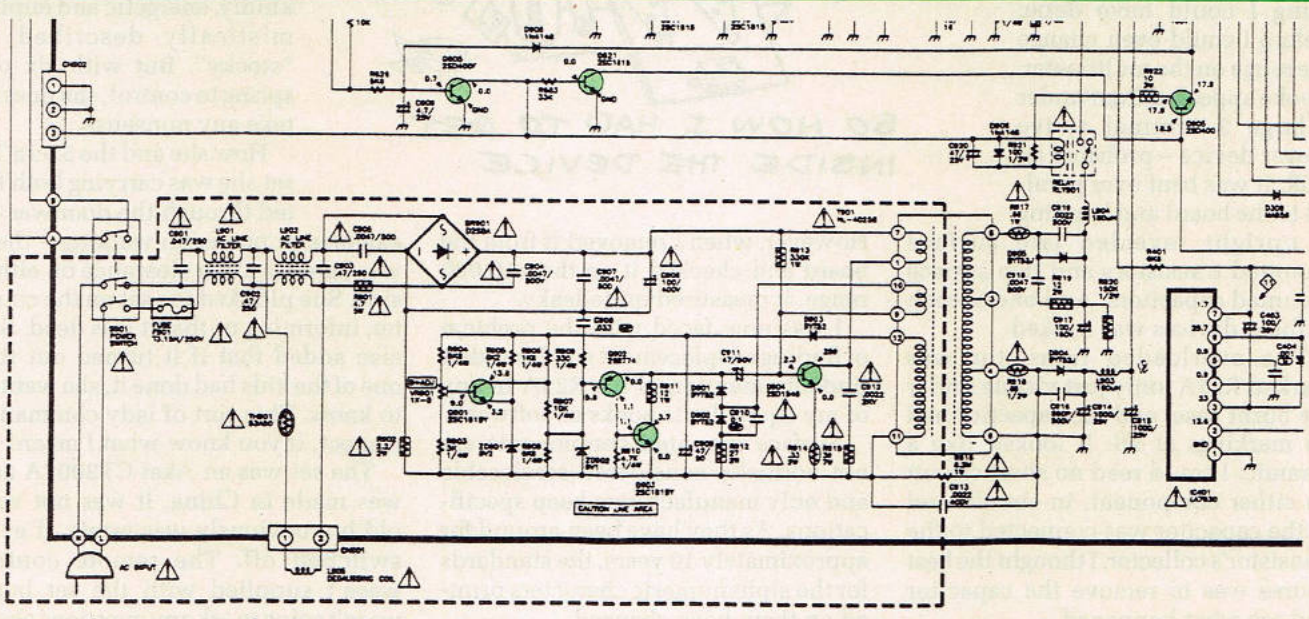


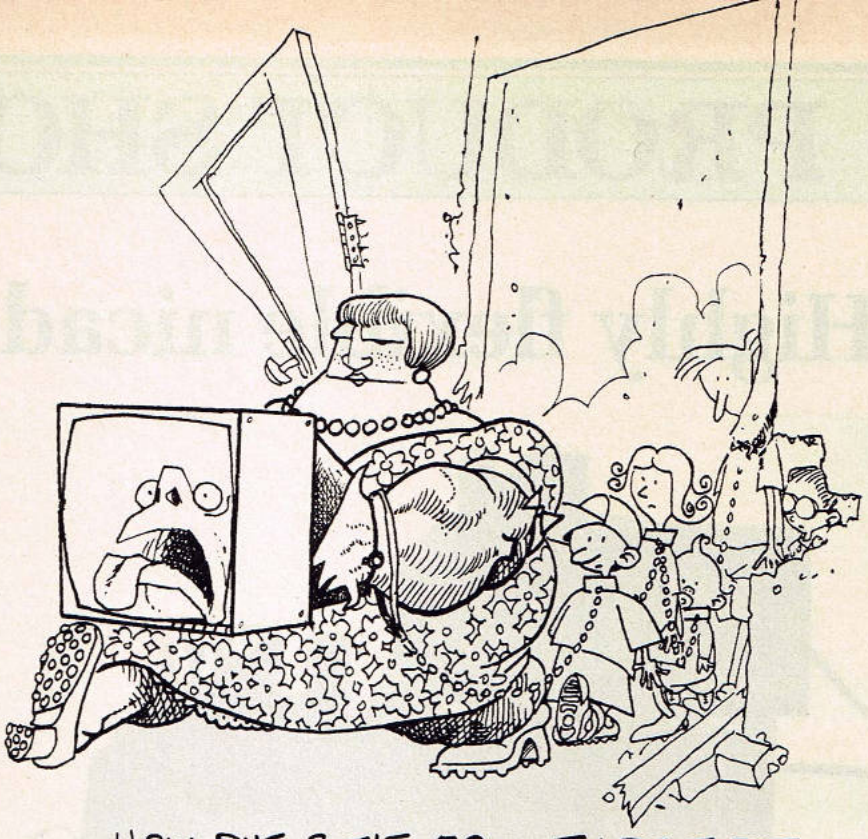
Fig.1: the power supply circuit for the Akai CT2007A. Relay RLY901 is towards top right and is driven by transistor Q905 (top righthand corner). This in turn is driven by transistors Q621 and Q605 at top left, with Q605's base fed from pin 15 of CPU IC601 (not shown here).

the power supply, especially C802 (10µF).

Retrace lines and an excessively bright picture are due to R418 going high or the screen potentiometer itself (VR406). No picture or a very dark picture can be R419 going high. The classic fault for sets near the beaches is failure of the 22MΩ focus control (VR201), which sometimes sounds like a machine gun due to internal sparking. If the horizontal output transformer fails, it really means the end of the set's life because it is too expensive. The picture tube rarely fails and most are still good 17 years later.

The only thing left with the Colonel's General – I must stop saying that – was the UHF tuner, which was seized. To fix this, I removed the two knobs and the circlip, then using pliers, cutters and CRC 2-26, carefully removed the plastic sleeve control shaft and cleaned and lubricated it before refitting. There is no need to refit the circlip, as the tuning knob will keep the whole thing in place.

A little judicial greyscale setting completed the repair and it was back in service and returned to the front line with a happy Colonel Jones.



A puzzling Toshiba

And finally, a rather puzzling story about a Toshiba 259X7M 52cm TV set. This set has an unusual power supply, which is designed to adapt itself automatically to the supply voltage; approximately 240V for Europe and Australasia, or 110V for Japan and the Americas. More exactly, it looks like a 110V circuit, modified to 240V by using an additional module – U801 Power-2 Board PW6004.

But that is only general background. The complaint was straightforward enough; it was dead and blowing the mains fuse. Fuse F801 was open, as was expected, but there was more to it than that. More to the point, I hate blown fuses. Whenever I encounter one, my natural reaction is to ask why. What caused it to blow? Is the fault still present? And, if not, is it intermittent? And so on.

And I found a lot of "whys" in this case. Capacitor C835 was short circuit, as were transistors Q801 and Q802. And C816 and C447 also needed replacing.

That was all that was obvious but there could still be more subtle faults elsewhere and one needs to proceed carefully in such cases. In place of fuse F801 (3.15A), I substituted a 200W 240V globe and switched on. The globe lit up very brightly, implying that there was still a major short.

I began by disconnecting various circuits, starting with the 145V rail via plug M801 and fuse F802. This produced no change and it still glowed after I removed the degaussing coils. But was it still as bright? I couldn't be sure and I was thrown off the scent further by the globe intermittently dimming and brightening after a few minutes. I could not find any explanation for this.

With the 200W globe still in circuit, I noticed that there were now slight signs of a raster or picture on the screen, which implied that the 145V and 15V rails were probably OK. After checking the bridge rectifier (D831-D834) for shorts, I decided to risk trying another fuse in F801.

At switch-on, the sound and picture were completely restored. So far, so good but the degaussing coils were still unconnected. I reconnected them and – *splat!* – the fuse blew again. There isn't much that can go wrong with degaussing coils but the thermistor network that's used to control the degaussing cycle can give trouble.

Basically, this network consists of two major components; a positive temperature coefficient thermistor in series with the coils and a negative temperature unit in parallel with the coils. This arrangement may use two separate thermistors or, more commonly these days, a single package containing both devices. In this case, there was a single package designated as a PTC/PTH dual posistor (R890).

Because it was the number one suspect, I reefed it out, noted that something rattled inside and tossed it. I fitted a new one and switched on. The fuse remained intact and after testing it for a few days, I pronounced it reliable enough to go back to the customer.

But with so many faulty parts involved, the logical question is which failed first? I can't answer that; your guess is as good as mine. All I know is this: I still hate blown fuses. One can never be sure what has blown them and it can take a lot of effort trying to find out, not always successfully. **SC**

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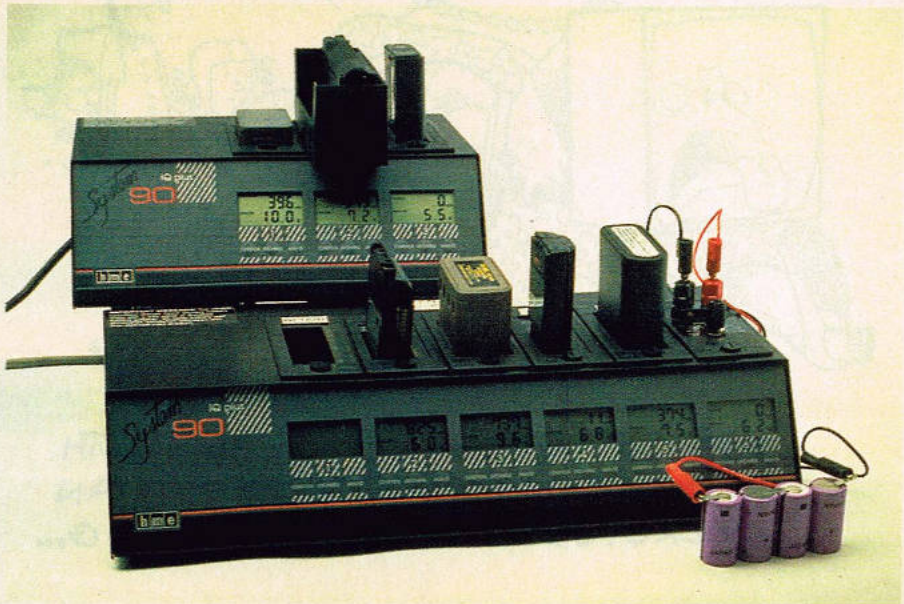

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New adaptors are released weekly to meet the demands of users and as new equipment comes into operation. Many adaptors are custom manufactured in Australia to customers' requirements without additional cost. Availability from design to manufacture is less than one week.

For further information, contact Premier Batteries Pty Ltd, 9/15 Childs Road, Chipping Norton, NSW 2170. Phone (02) 9755 1845; fax (02) 9755 1354.

Power supply and case

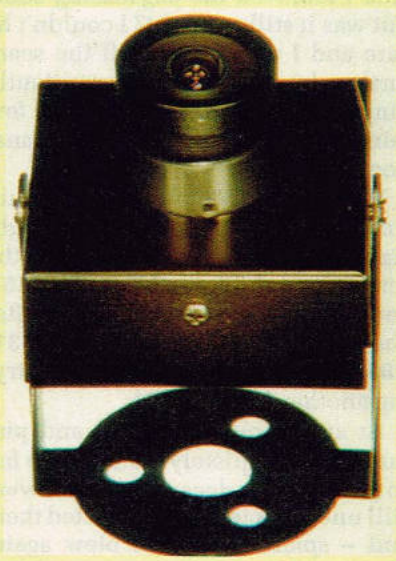
This neat computer case measures 363mm wide, 280mm deep and just 55mm high. Inside it has a switchmode power supply providing 5V @ 6A, 12V @ 2A and -12V @ 0.5A. On the rear panel is a switched and fused 240VAC IEC socket and female IEC socket. There are also a number of cutouts on the rear panel.

What would you use it for? We dunno. Perhaps a computer periph-

Tiny video surveillance camera

Available from Allthings Sales & Services is this tiny CCD video surveillance camera. It has a metal case, is fitted with a 3.6mm board or 5.5mm pinhole lens and is supplied with a metal wall mounting bracket. The dimensions are 36mm (W) x 36mm (H) x 27mm (D) with board lens or 17mm (D) with pinhole lens and weight is just 100 grams.

Main specifications are 380 lines horizontal resolution, 0.2 lux sensitivity for low light and infrared use, 1/50 to 1/100 000 second linear automatic electronic shutter,

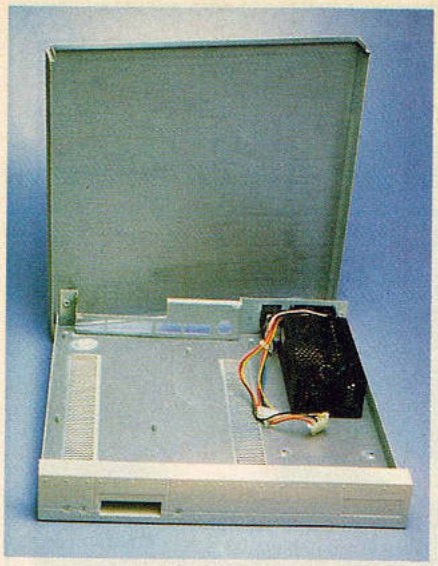


12VDC input via a 2.1mm DC socket and standard 75Ω composite video output via a BNC socket.

Options and accessories include 14 lenses from 2.1mm to 12mm focal length, an infrared filter to enhance resolution, sharpen focus and improve colour to grey conversion, polarising and infrared long pass filters for glare, focus and exposure control, infrared illuminators and IR light emitting diodes.

The price, including tax, with 3.6mm or 5.5mm lens is $99.00.

For full details and specifications, contact Allthings Sales & Services. Phone (08) 9349 9413; fax (08) 9344 5905.



eral or two? Or it could be ideal for the multimedia sound amplifier system described in the October 1966 issue of SILICON CHIP. Even if you throw away the case, keep the power supply and the IEC sockets it will still be a bargain at $20 plus $6 for freight.

Where do you get it? From Oatley Electronics, PO Box 89, Oatley, NSW 2223. Phone (02) 9584 3563; fax (02) 9584 3561.

500MHz logarithmic amplifier IC

Analog Devices has released a new device which allows designers to measure signal strength at intermediate frequencies (IF) up to 500MHz. Previous lower speed log amplifiers required one or more expensive mixing/filter stages prior to the log amplifier. The AD8307's exceptional speed (up to 500MHz), dynamic range (86dB), accuracy (±1.0dB), small package (industry's first 8-pin SOIC log amp) and ease-of-use allow system designers to achieve consistent performance while reducing subsystem cost by 50%.

A logarithmic amplifier is a key building block in a wide range of radio-frequency (RF) applications/systems. Most RF systems require two mix-down stages, one to intermediate frequency (IF) and the other to baseband. Since the AD8307 eliminates the need to mix down to baseband, the last mixing stage can be eliminated, significantly reducing subsystem cost.

The AD8307 uses a single supply of 2.7-5.5V and draws 8mA. This results in very low power consumption of 24mW while operating on 3V. A power-down control pin allows further power saving by putting the device into a standby mode where it draws only 750µA.

For further information, contact Hartec, 205A Middleborough Road, Box Hill, Vic 3128. Phone 1800 33 5623.

AUDIO MODULES

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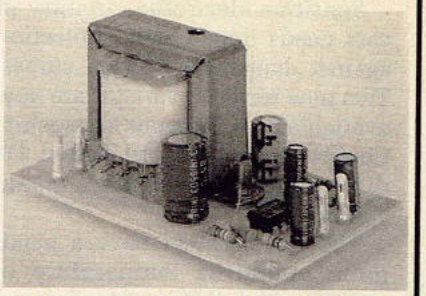

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Value for Money 60MHz & 100MHz Scopes

Tektronix' new TDS-200 Series scopes are affordable, compact, general purpose digital storage scopes that offer more additional facilities than any analog scope.

The technological breakthrough that these new scopes offer is an extraordinarily high **1GS/s real-time digitising rate** plus a very rapid screen update rate, resulting in a digital scope with display response of an analog scope, at an analog scope price.

The TDS-200's are specifically designed to make general purpose waveform measurement, TV and video signal work much quicker, more reliable and versatile.

Screen displays can easily be down loaded to a PC using the TDS-200's optional serial/parallel/GP-IB interface, the **TDS2CM**.

2 models are available:
TDS210: 60MHz at $1395 ex-tax &
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TDS-200 Series Features -
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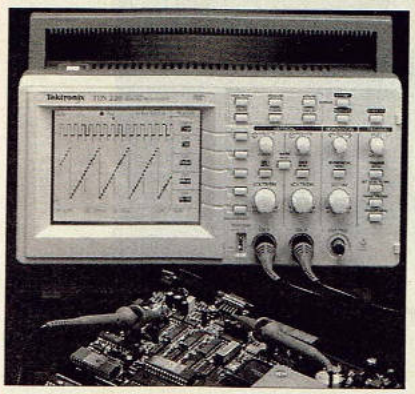

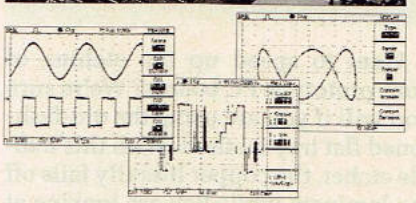

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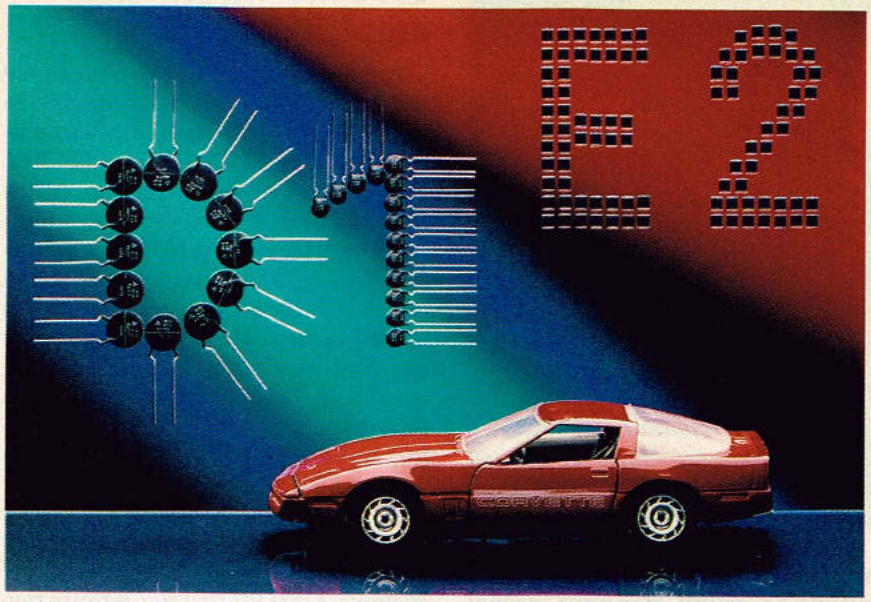
Varistors for automobiles

Sensitive electronic circuitry in cars needs dependable protection against dangerous voltage surges. Two new series of varistor are now available from Siemens Matsushita Components: radially leaded D1 disc varistors and E2 surface-mount variants.

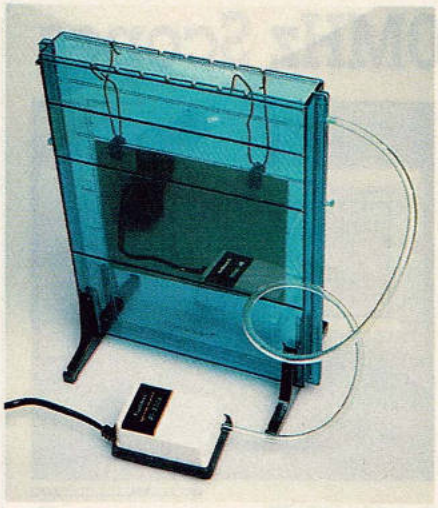
The D1 varistors have a maximum operating temperature of +125°C with full DC and load-dump capability. Typical applications include use in motor controllers or protection of high-voltage gas-discharge lamps. Diameters range from 5-14mm, the latter being able to absorb up to 50J load-dump energy.

The E2 SMD varistor has a 25J load-dump energy absorption capability and can withstand a maximum current surge of 1200A. A protection level of 40V at 10A plus a temperature range to +125°C make it a practical alternative to earlier 10mm disc varistors.



For further information contact Advanced Information Products, Siemens Ltd. Phone (03) 9420 7716; fax (03) 9420 7275. Email: passive.comp@siemens.com.au

Bubble etcher for PC boards



Want to speed up the etching of your prototype PC boards? We're sure you will if you are using the old-fashioned flat tray method. With this bubble etcher, the copper literally falls off the laminate while you are looking at it.

It can take boards up to 250mm long and 200mm wide and requires up to 1.5 litres of etchant to do the job. A number of plastic clips are included to support the board while it is etching. The bubbles are provided by a 240V fishtank air pump.

Available from all Dick Smith Electronics stores, the bubble etching tank is priced at $49.95 while the air pump is $10.

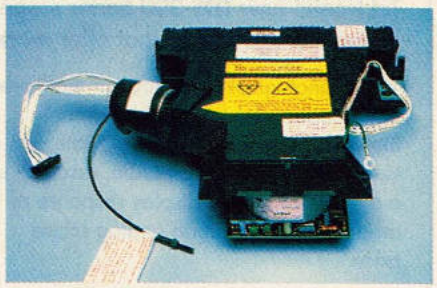
Baby robot – not just a toy

Eshed Robotec have released a new Scorbot ER-1 robot which is the baby of the family. The intelligence of this robot lies in the controller and the software. The controller is based on the Intel 8031 CPU and has eight TTL inputs/outputs for connecting external circuitry. The software assists the programmer by preventing syntax problems and missing parameters for commands. No previous programming experience is necessary.

A Teach Pendant is available for teaching positions, charting movements and running programs with a push of a button.

For more information contact Stanton Australia Pty Ltd, PO Box 4760, North Rocks, NSW 2151. Phone (02)9894 2377; fax (02) 9894 2386.

Laser engine for satellite destruction



OK, OK, this laser engine might not have sufficient ergs to penetrate the full height of the planet's atmosphere and then have enough left over to disable an unwanted satellite but you might have fun trying. Actually, these laser engines have come out of standard laser printers. They have a polygon scanner with a crystal controlled driver board, a 5mW 780nm laser diode in a collimated housing, mirrors and lenses.

These are priced at just $35 plus $6 freight from Oatley Electronics, PO Box 89, Oatley, NSW 2223. Phone (02) 9584 3563; fax (02) 9584 3561. SC

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RADIO CONTROL

BY BOB YOUNG

How servo pulses are transmitted

This month we take a look at the method of transmitting servo pulses using pulse position modulation. This is another form of serial data transmission except that it is via a radio carrier instead of two wires, as used for computer data.

Last month, we established the basic parameters for the input pulse used in a typical R/C servo. Fig.1, reprinted from last month, details these parameters. This pulse must appear at the input for each servo used in the R/C system and hence an 8-channel system will have eight pulses in the data stream.

Last month we also established that the servo works with a modulated width input pulse. If the pulse is wider than 1.5ms, the servo will move clockwise with respect to the neutral position and if it is narrower than 1.5ms it will move anticlockwise.

More particularly, while it was not stated last month, the servo's final position, after it has settled, is proportional to the position of the trailing edge of the input pulse. Now the problem with serial transmission of this form of pulse is that there must be some form of identification of the position of the leading and trailing edges of each pulse.

This is at complete odds with normal serial data transmission in which a sample is taken to establish whether the bit is high or low. The edges of the pulse play no part in the usual form of serial data transmission. Thus, for example, we could have a situation where all eight data bits are high and all we would see on an oscilloscope would be a solid high block (pulse) eight bits long with no gaps to identify the start and finish of each individual pulse (or bit).

An additional complication is the fact that the trailing edge is not fixed and may vary between 1-2ms after the leading edge. Therefore if we are to serially transmit eight width modulated pulses, we need to separate each pulse with a marker pulse. So how do we transmit this form of data quickly enough to keep the servo response times as low as possible, so as not to introduce delays in the control response?

It is here that the cleverness of the two NASA engineers who designed the original digital proportional system really shows through. Doug Spreng and Don Mathers in the early 1960s not only designed a very clever servo system, they also designed a most efficient form of serial data transmission. There are no wasted pauses or periods in their system. Depending upon the number of channels in the system, one complete frame can be transmitted in as little as 14-25ms.

The formula for frame rate is:

$$F_R = ((X \times 2) + 6))ms$$

where X = the number of channels while the "6" is the sync pause in milliseconds. Thus the frame rate for a 24-channel system would be $24 \times 2 + 6 = 54ms$. This is about as slow as the system can run because the pulse stretchers in the servos can not hold the charge for much longer. Also the delay in response time starts to become noticeable after this.

It is difficult for the modern R/C flyer to appreciate just how revolutionary the original digital proportional system was when it was first introduced. Overnight we went from reeds with ON-OFF controls and perhaps two simultaneous controls, if we were lucky, to a rock-solid proportional system of unprecedented reliability with all controls simultaneous. It was a breathtaking development and a giant leap forward and now it is all taken for granted.

True, there were analog simultaneous proportional systems but these were full of shortcomings and never really fulfilled the role required of them. Overnight the Mathers and Spreng system swept all before it and

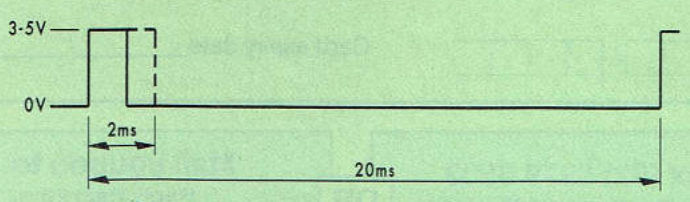

Fig.1: typical input pulse parameters for an R/C servo. This pulse must appear at the input for each servo used in an R/C system.

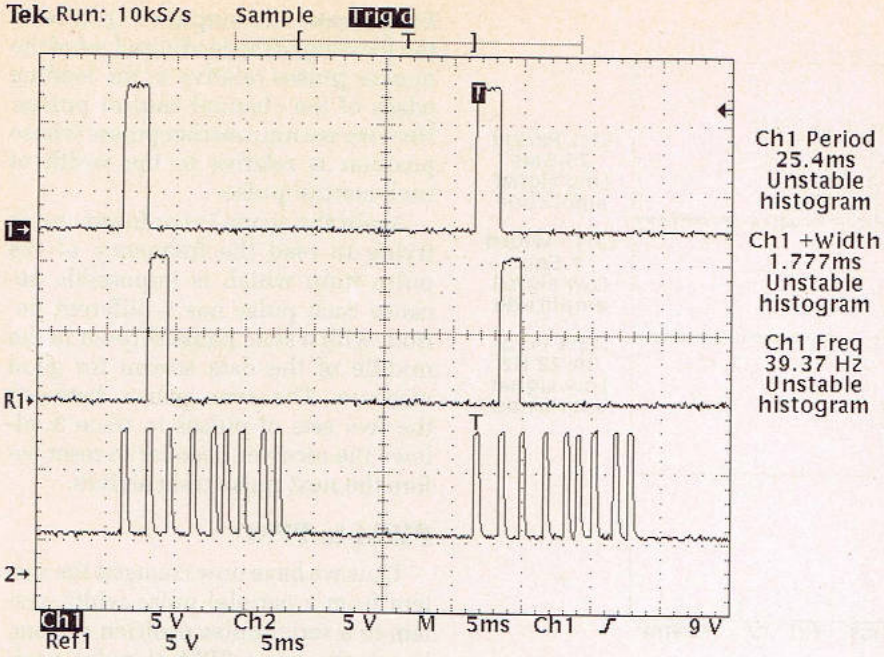

Fig.2: these scope waveforms were taken from an 8-channel R/C transmitter. The bottom trace is the encoded pulse train, while the two traces above it are the width-modulated pulses for the first two channels.

their system became the international standard for over 30 years. It is only now being rivalled but not replaced, by PCM, a standard bitstream form of serial data transmission. Even here though, the Mathers and Spreng servo system is still used, with the PCM data being converted to pulse width data before being fed to the servo.

In other words, the PCM system is merely used to transmit the pulse width data. It is interesting to note that in theory PCM should give better results than PPM for two reasons. First, it is more difficult to transmit edges reliably than just to sample bits for high or low. The edges in a PCM system play no part in the carriage of information. Second, computers are very good at error detection and correction, yet in practice the PCM systems fail to live up to this promise. There is a flaw in the basic design philosophy of the modern PCM system it would appear.

Pulse position modulation

The system of data transmission devised by Mathers and Spreng is now known as Pulse Position Modulation (PPM). Fig.2 shows the timing diagrams from an 8-channel transmitter using pulse position modulation.

The bottom trace is the encoded pulse train, the serial data stream if you like, while the two traces above it are the width-modulated pulses for the first two channels. Note how the start of the channel 1 pulse (top trace) coincides with the start of the pulse train in the bottom trace. And note how the end of the channel 1 pulse coincides with the start of the channel 2 pulse (middle trace). You can also see how the start of the channel 2 pulse coincides with the start of the second pulse in the encoded pulse train.

Marker pulses & sync pause

In fact, the encoded pulse train is a series of "marker pulses" where each marker pulse identifies the end of one channel's pulse and the start of the next channel. There is one extra pulse in the system which is the start marker. This identifies the end of the sync pause and the start of the channel 1 pulse.

Therefore, the bottom trace in Fig.2 shows the modulating waveform for an 8-channel PPM transmitter encoder and it has nine marker pulses. A 6-channel system would have seven marker pulses.

To understand how this serial data stream is compiled, it is best to examine one of the early "half shot" encoders, which illustrates the principles involved more clearly than one of the modern IC encoders such as the NE-5044.

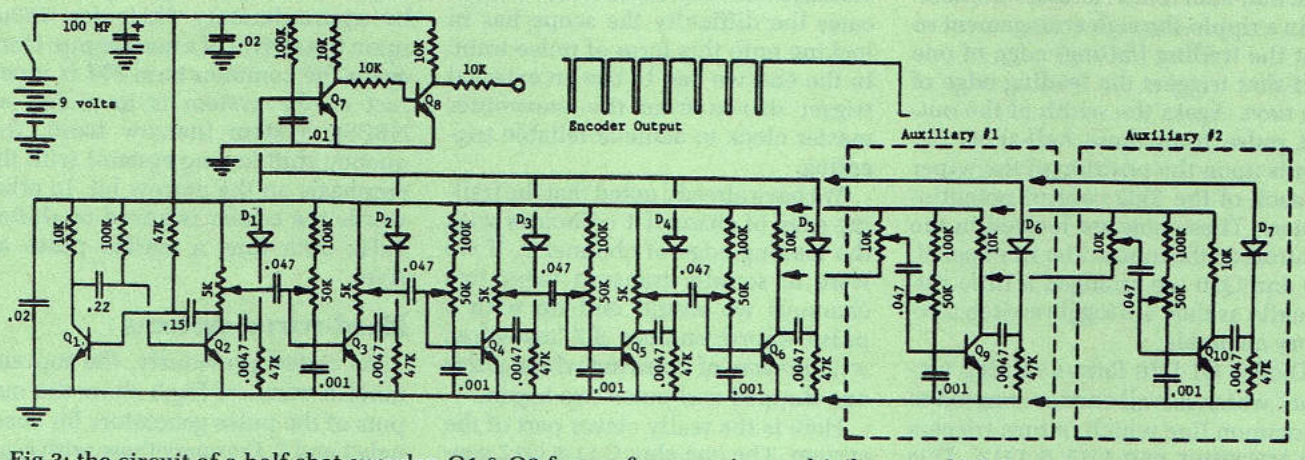

Fig.3: the circuit of a half-shot encoder. Q1 & Q2 form a free-running multivibrator which is set at 25.4ms. This is the master clock for the encoder. Q3 to Q10 are eight identical half-shot multivibrators connected in a ripple-through arrangement so that the trailing (falling) edge of one half-shot triggers the leading edge of the next.

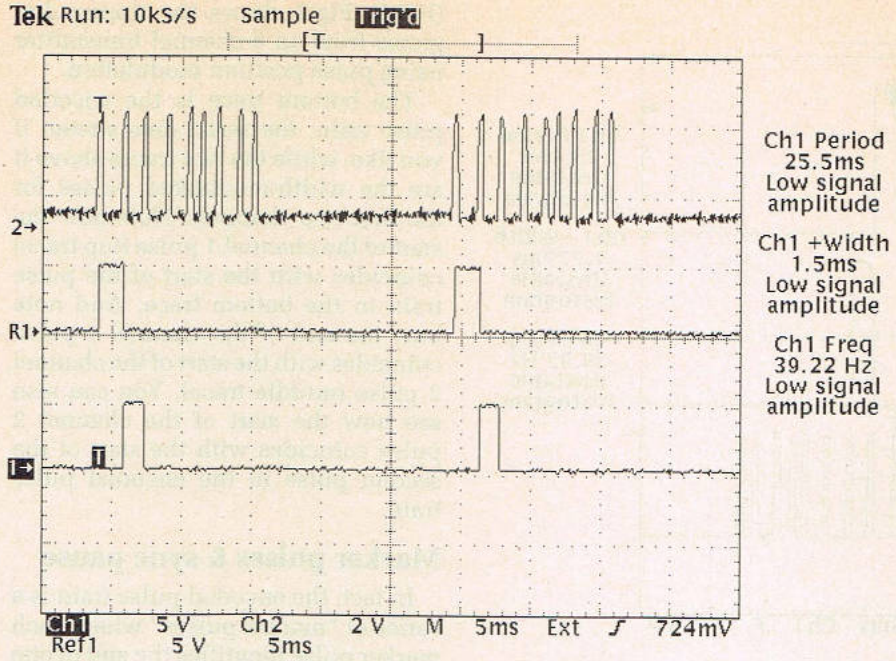

Fig.4: these scope waveforms were taken from a 8-channel R/C receiver decoder. Trace 1 shows the output of the receiver detector. Traces 2 & 3 are the decoded width-modulated pulses for channels 1 & 2 and are identical in form to the waveforms in Fig.2.

Fig.3 is a circuit of a half-shot encoder similar to that used in the Silvertone transmitters from 1969 to 1974. Q1 and Q2 form a free running multivibrator which is set at 25.4ms. This multivibrator is the master clock for the encoder. The falling edge of the clock pulse triggers half-shot Q3 whose duration may vary between 1-2ms depending upon the setting of the 5kΩ potentiometer in the collector load of Q2.

Follow the leader

Transistors Q3-Q10 are eight identical half-shot multivibrators connected in a ripple-through arrangement so that the trailing (falling) edge of one half-shot triggers the leading edge of the next. Again the width of the output pulse from these half-shots depends upon the position of the wiper in each of the 5kΩ control potentiometers. These pots are located in the controls on the transmitter front panel. Q9 and Q10 are arranged a little differently as they are toggle switch auxiliary channels.

Diodes D1-D10 form a mixing network which has all anodes coupled to a common line which in turn triggers the transistor pair Q11 & Q12. This pair of transistors is arranged as a one-shot multivibrator with a pulse output of 350µs. This one-shot acts as a marker pip generator.

Referring again to Fig.2, the top trace shows the output of Q3 (channel 1) which is a positive-going pulse of about 10V amplitude and about 2ms in duration. In this case, the oscilloscope has measured the frame rate which is the period between the leading edge of each control pulse and is shown as 25.5ms.

Trace 2 shows the output of Q4 which is the channel 2 pulse and in this case the scope has latched onto the pulse width which is shown as 1.77ms. The "unstable histogram" comment on each measurement indicates the difficulty the scope has in locking onto this form of pulse train. In the end we had to use an external trigger driven from the transmitter master clock to achieve reliable triggering.

We have already noted that the trailing edge of channel 1 coincides with the leading edge of channel 2. If we were to serially transmit these two channels we would end up with a pulse approximately 3.77ms wide, with no way of knowing where pulse one stopped and pulse two began.

Here is the really clever part of the system. The one-shot Q11 & Q12 generates a 350µs marker pip every time a falling edge is generated by transistors Q2-Q10. So the bottom trace of Fig.2 shows the output of Q12. Note the location of the leading edges of the marker pulses relative to the leading edges of the channel control pulses. Here we see nine marker pulses whose position is relative to the width of each control pulse.

Again the scope is confused and is trying to read the frequency of the pulse train which is impossible because each pulse has a different period, with a sync pause thrown in the middle of the data stream for good measure. The sync pause, between the two sets of pulses in trace 3, allows the receiver decoder to reset before the next pulse train arrives.

PWM to PPM

Thus we have now changed the system from a parallel pulse width system to a serial pulse position system, hence the name PPM or pulse position modulation. The data is carried in the position of each marker pulse. The output of Q12 is inverted in the modulator and the negative-going pulse train is used to modulate the transmitter, be it AM or FM.

In the case of AM (amplitude modulation), the carrier is spiked or gated OFF for 350µs by each marker pip. Thus, as we have discussed previously, it is more correct to refer to the AM system as a "gated carrier" system as the carrier is not amplitude modulated in the normal sense, merely switched ON or OFF. This form of modulation results in a very strong carrier for nearly 90% of the time and results in a solid relatively noise-free receiver signal.

In the case of FM (frequency) modulation the carrier frequency is shifted by approximately 3kHz for 350µs upon the arrival of a marker pip. Once again the common term FM is incorrect as the system is in reality an NBFSK system (narrow band, frequency shift keying system) with the emphasis on the narrow bit. In other words the carrier is keyed or shifted 3kHz each time a marker pulse arrives.

Hard-wired systems

As stated previously, the top and middle traces of Fig.2 show the outputs of the pulse generators for channels 1 and 2. Compare these with Fig.1 and it is obvious that except for the amplitude, the two traces are exactly what we need to drive a servo. Had

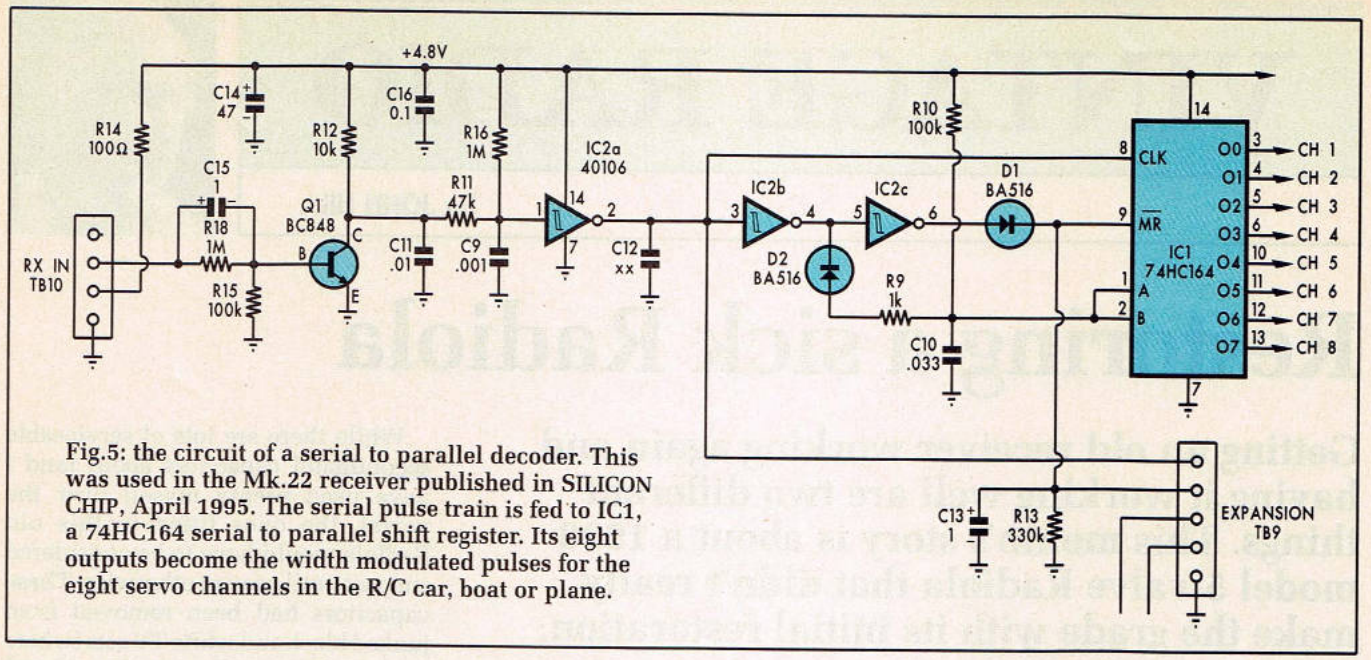

Fig.5: the circuit of a serial to parallel decoder. This was used in the Mk.22 receiver published in SILICON CHIP, April 1995. The serial pulse train is fed to IC1, a 74HC164 serial to parallel shift register. Its eight outputs become the width modulated pulses for the eight servo channels in the R/C car, boat or plane.

the encoder been set up to run from 5V we could have hooked up servos to the collectors of Q2-Q10 and driven all eight servos direct from the encoder. For hard-wired systems this is quite feasible but for transmission over a twisted wire pair or radio link the data must be serially encoded as in Fig.2, trace 3.

In the modern multiplexed encoder it is not possible to drive the servos direct from the encoder and a decoder must be used in this case with a twisted wire pair. The Silvertone Mk.22 encoder has a plug specifically built in for this purpose.

Serial data decoding

In the R/C receiver, the process is reversed. Fig.4 shows the timing diagrams for a receiver decoder and Fig.5 shows the circuit of a serial to parallel decoder. This was used in the Mk.22 receiver published in SILICON CHIP, April 1995.

Fig.4, trace 1 shows the output of the receiver detector and is identical in form to the output of the transmitter one-shot. This signal is amplified and squared up through the pulse shaper Q1, IC2a, IC2b & IC2c.

The cleaned up pulse train is fed to the appropriate pins on IC1. This is a 74HC164 serial to parallel shift register. The clock pulses are fed directly into pin 8 from IC2a. IC2b drives a sync separator consisting of diode D2, R9 & C10 which holds pins 1 and 2 of IC1 low as long as the 1-2ms pulses are present. During the long sync pause, pins 1 and 2 go high and the shift register is reset, ready to receive the channel 1 start pulse.

IC2c, D1, R13 and C13 form a chip-enable driver which will hold pin 9 high so long as the clock pulses continue to arrive from the receiver. If these pulses disappear, then pin 9 will go low and the chip will be disabled. This protects the servo gears in the event of a transmission failure or the receiver being on when the transmitter is switched off. If the chip is not disabled, noise spikes may get through from the receiver and drive the servo up against the end stops, damaging the gear train.

With the correct conditions on pins 1, 2 and 9, the pulses will be clocked through the shift register so that an exact copy of the encoder pulse appears at each of the output pins Q0-Q7.

Referring again to Fig.4, trace 2 shows the output of channel 1 which is an exact copy of the channel one pulse from the encoder except for amplitude. Likewise Fig.4, trace 3 shows the output of channel 2. Each of the output pins Q0-Q7 will mirror the transmitter encoder channels. Thus we have now converted the system back into a parallel. pulse width modulated system.

Note that the output of the decoder is identical to the parameters published last month for the servo input.

All we have to do now is to hook a servo to each of the channel output plugs and we have an 8-channel proportional radio control system. Even after working with this system for 32 years I still marvel at the magic of being able to maintain such complete and precise control over a model, at a distance, with no strings attached. **SC**

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VINTAGE RADIO

By JOHN HILL

Restoring a sick Radiola

Getting an old receiver working again and having it working well are two different things. This month's story is about a 1938 model 5-valve Radiola that didn't really make the grade with its initial restoration.

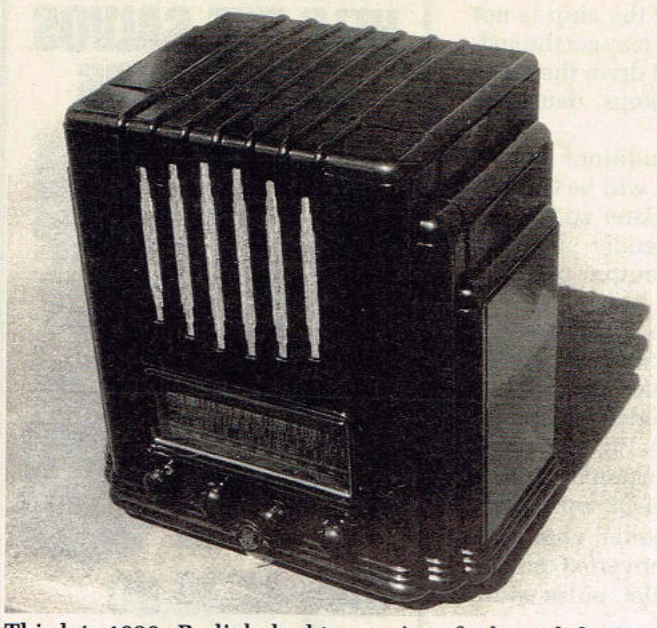
Restoring valve type radio receivers is a rewarding hobby for many vintage radio enthusiasts. Personally, I find the "getting them going" aspect the really interesting part of the process, particularly when one starts out with a completely inoperative piece of equipment. It is indeed satisfying to hear such a set burst into life after being silent for many years.

The old Radiola was bought to me by a collector friend to see if I could find out what was wrong with it. Basically, the set worked on strong transmissions but the weaker stations just weren't there. It also performed worse at the high frequency end of the dial than at the low frequency end. As stated earlier: working and working well, are two different things.

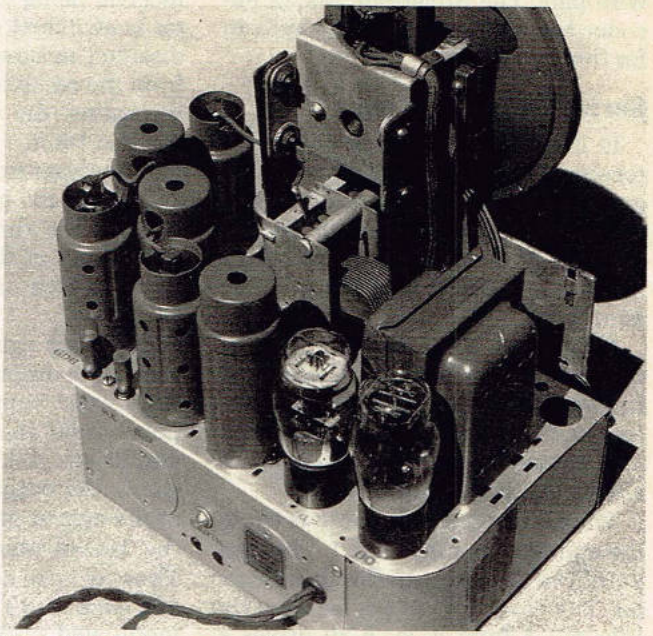
At first glance, the set appeared to have been reasonably well restored. All paper and electrolytic capacitors had been replaced, even if the majority of these components had been substituted with secondhand parts.

While there are lots of serviceable secondhand capacitors about (and I have used plenty myself over the years), the ones fitted to this old Radiola would have to be considered suspect until proven otherwise. These capacitors had been removed from junked black and white TV sets (where he found these I'll never know) and installed in the Radiola without being tested, so a faulty capacitor looked like a good possibility.

Unfortunately, in order to test such capacitors they must first be isolated, which involves unsoldering one connection on each capacitor. Each capacitor was checked in turn with a megohmmeter set to the 500V range. As it turned out, however, all the old polyesters tested perfectly without the slightest hint of leakage. The electrolytics also checked out OK.



This late 1930s Radiola had two serious faults: a defective IF transformer and a loose voice coil winding in the loudspeaker which produced less than perfect results.



The old Radiola was a fairly compact receiver for its era, as this top view of the chassis shows. The set had been reasonably well restored using mainly secondhand parts.

Old valve radios also have mica capacitors and these can sometimes break down and cause all sorts of trouble. As a result, these were also disconnected and tested for leakage at high voltage. They all passed the test without problems.

The resistors were next and each one was checked to see if it measured what it was supposed to. All this test revealed was that they were all well within their normal 20% tolerance.

At this stage, I decided to check all the valves. And once again, in keeping with the previous tests, they were all in excellent condition. So far, quite a lot of time had been spent getting absolutely nowhere!

Set procedure

Whenever I do a restoration, I have a set procedure which starts with continuity checks on a number of critical components in order to establish their serviceability. These components are: the aerial and oscillator coils, the intermediate frequency (IF) transformers, the high-tension filter choke or field winding, and the output transformer. In addition, I also check the primary and secondary power transformer windings.

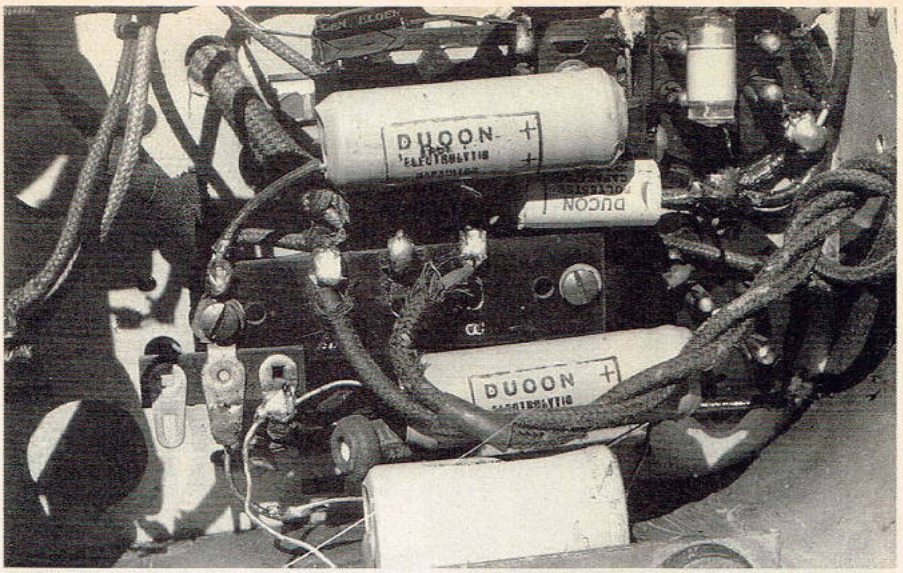
It was time to apply these checks to the old Radiola. The fact that the set was working at all had drawn my attention away from these components which are normally the first things I check.

Sure enough, a major fault was soon located. The first IF transformer secondary winding was open circuit. This malfunction reduced the radio frequency signal to the IF amplifier valve, so it was no wonder the set performed so badly. In fact, it is a miracle it worked at all!

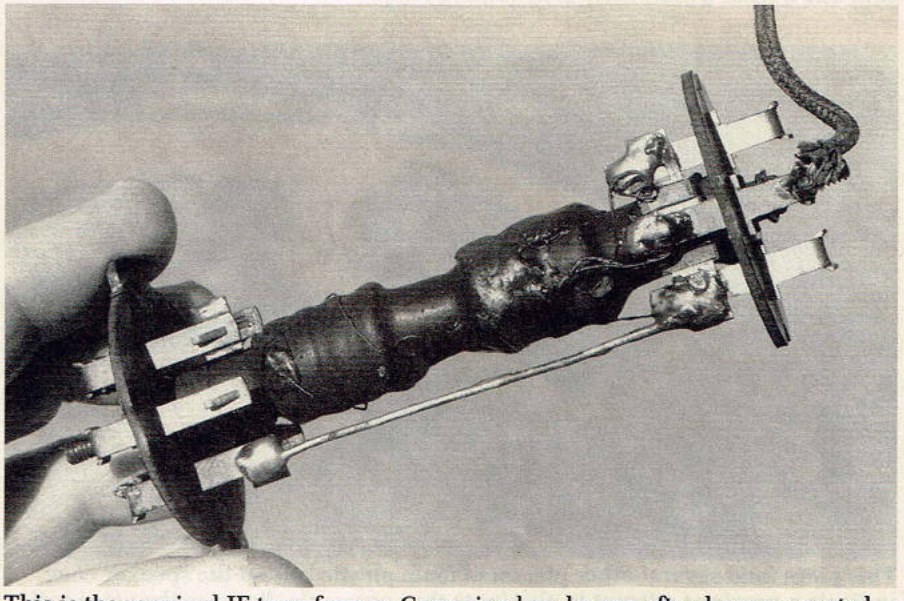
A closer inspection revealed that the iron core adjustment for the transformer secondary had also been adjusted fully in. This would be part of the reason for some RF transfer to the IF amplifier valve.

Perhaps if I had used my signal tracer to help sort out this problem, the faulty IF transformer would have been found sooner. But as the old signal tracer is too big to fit comfortably on the workbench, it is only used as a last resort when all else fails.

The solution to the problem was to either repair or replace the defective IF transformer. The first step was to remove it from the chassis and this was done after making a sketch of the wiring connections. Wiring sketches are a good habit to get into when removing major components for repair.



The restoration had been done using secondhand capacitors stripped from an ancient TV receiver. Although initially suspect, they all tested OK.



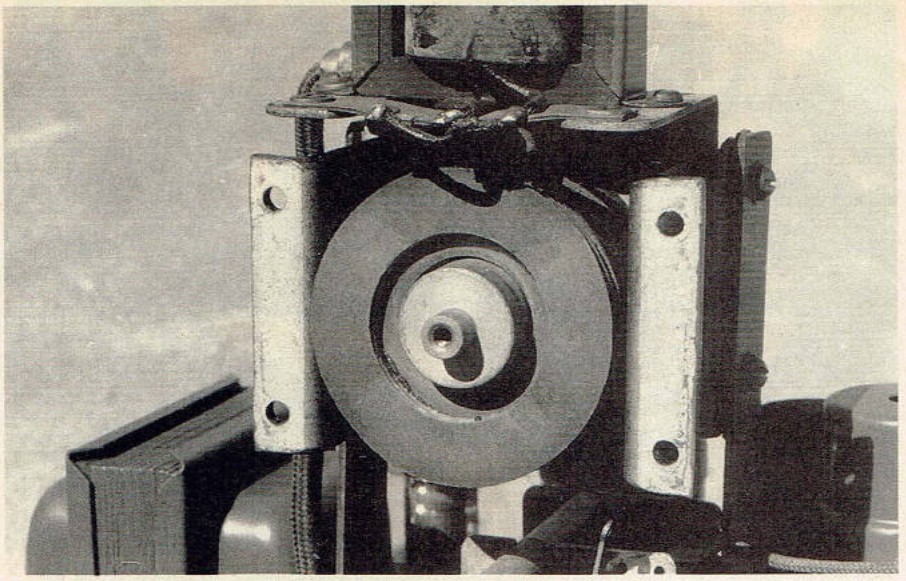
This is the repaired IF transformer. Corrosion breaks can often be reconnected, thus restoring the transformer to working order.

The transformer windings were of multi-strand (Litz) wire and one end of the secondary looked very suspect where the wax coating had cracked open due to aging. Several turns had to be removed before the break was found and testing with an ohmmeter revealed continuity from that point to the other end of the winding.

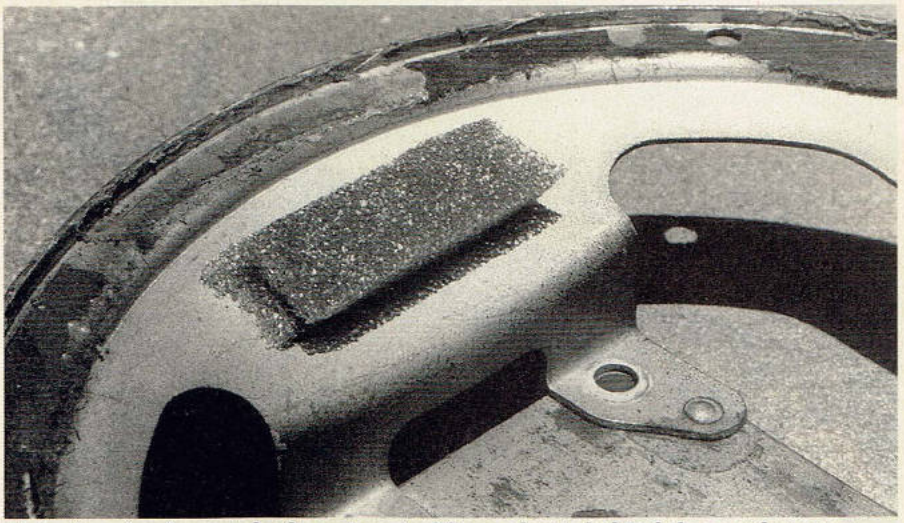
Fortunately, a few turns less on the secondary winding would have little affect on the IF transformer operation. Because the transformer had an adjustable iron core, it would be easy to compensate for the lost turns. What's more, no special winding technique would be required to replace the unravelled wire. All I would have to do is remake the termination and reseal the exposed wire with wax.

A distinct rattle

That simple repair solved the poor performance problem of the old Radiola and, after a quick alignment session, the set worked quite well. However, this improved performance brought to notice another fault which



This view shows the defective loudspeaker with the frame and cone removed. Shown is the central pole piece (electromagnet) surrounded by the hum-bucking coil. The output transformer is mounted on top.



This piece (and several other pieces) of foam plastic behind the speaker cone indicate a previous attempt to eliminate the cone rattle. Because the voice coil assembly was loose, the attempt was unsuccessful.

would require attention before the restoration could be called complete.

When the volume was turned up, there was a distinct rattle from the loudspeaker. This is a common problem in old speakers and is often caused by the cone separating from its outer rim. Alternatively, the rim can come adrift from the speaker frame.

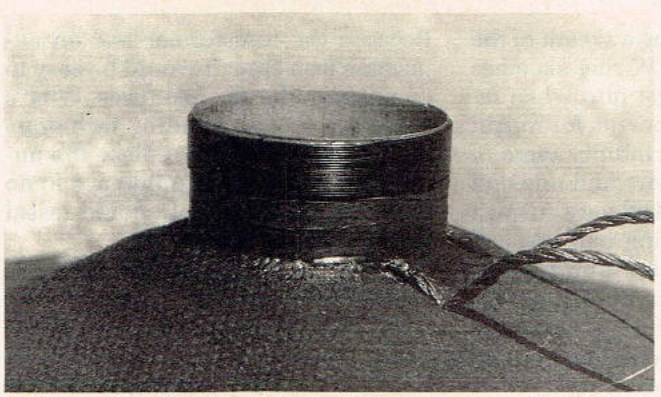
However, after checking these possibilities the rattle was still there. This can leave only a few other possibilities: either a loose voice coil or voice coil winding, or the voice coil polling on the magnet.

One good feature of many old electrodynamic loudspeakers is the fact that they can be dismantled and repaired. Back when these speakers were commonplace, new speaker cones and field windings were available as spare parts, thus making them reasonably easy to repair when things went wrong. During the latter part of the electrodynamic era, however, the loudspeakers were riveted or spot welded together which effectively ruled out disassembly and repair.

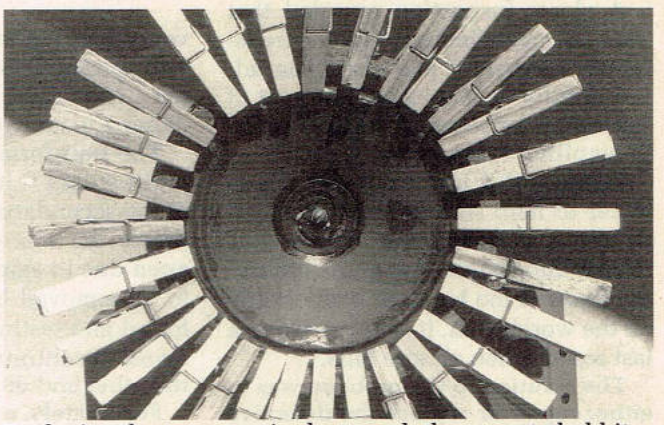
After removing the speaker cone (with minimal damage) the trouble spot was clearly visible – the voice coil winding was loose. It had also been rubbing on the close fitting frame and the enamel insulation on the wire had been worn away from the outside of the coil.

A simple remedy

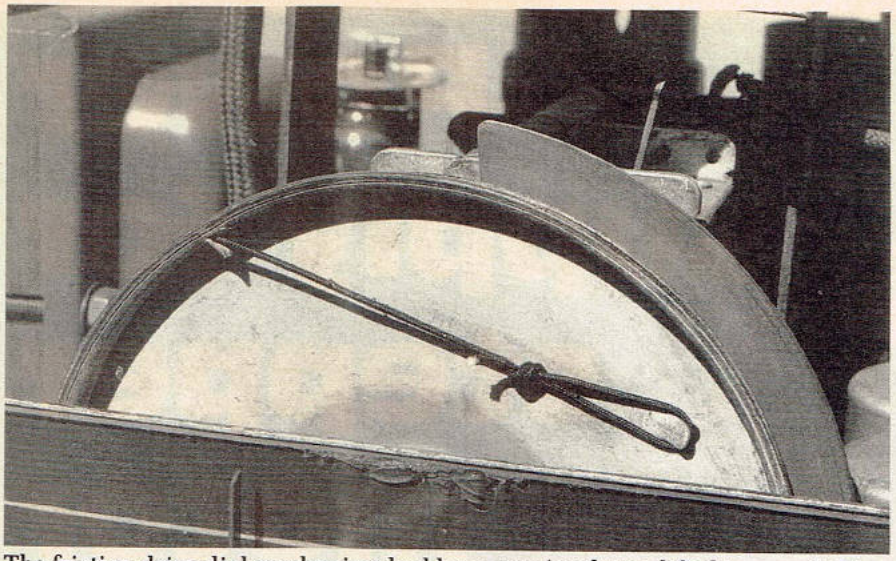
The remedy was simple. The voice coil was given a couple of coats of Shellac (although any lacquer will do) and the close-fitting ring in the frame that encloses the voice coil was slightly enlarged (in a lathe) to give the coil a little more clearance.



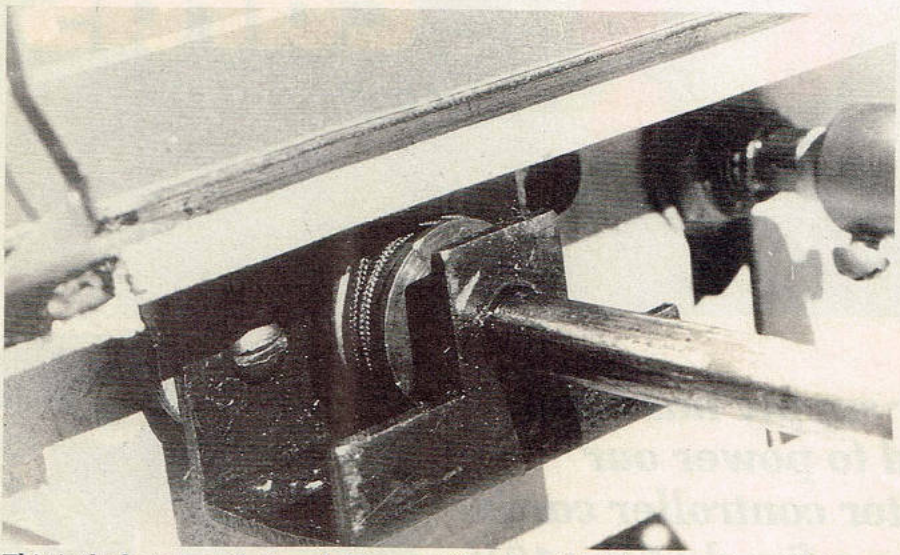
A few coats of Shellac solved the loose voice coil problem. The voice coil is wound on a thin cardboard former which is inclined to go out of shape over a long period, thereby loosening the coil.



Reglueing the cone required many clothes pegs to hold it in position. Several thin strips of shim brass were used to centralise the cone.



The friction drive dial mechanism had been previously modified to a cord drive. Note the cord drum in front of the old drive plate.



This is the bottom end of cord drive modification. The job was quite well done and is the logical thing to do if the original friction drive mechanism is badly worn or if parts are missing.

The cone was then glued back in position and held in place with clothes pegs until the glue dried. Three strips of "five-thou" shim brass were used to centre the voice coil around the electromagnet central pole piece prior to clamping the rim of the cone with the pegs.

It was a totally successful repair. The cone was quite free at the centre and the irritating rattle was completely cured.

Perhaps the most pleasing aspect of these two repairs is that, by spending a little time and effort, they resulted in the receiver working normally again. Some vintage radio repairers go to a lot of trouble tracking down hard to find spare parts when the existing parts can often be reclaimed with a little perseverance.

Nothing ventured . . .

When attempting a repair on a broken down or malfunctioning component, one has nothing to lose. If the job is unsuccessful, then you are no worse off for trying. If it is successful on the other hand, then you are well in front and have not only saved yourself some expense but have gained a great deal of satisfaction from fixing something that others may consider unserviceable. **SC**

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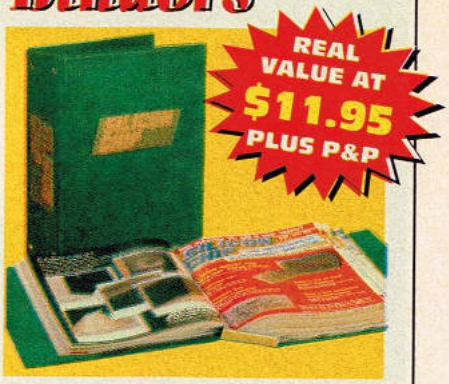

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Power supply for stepper motor cards

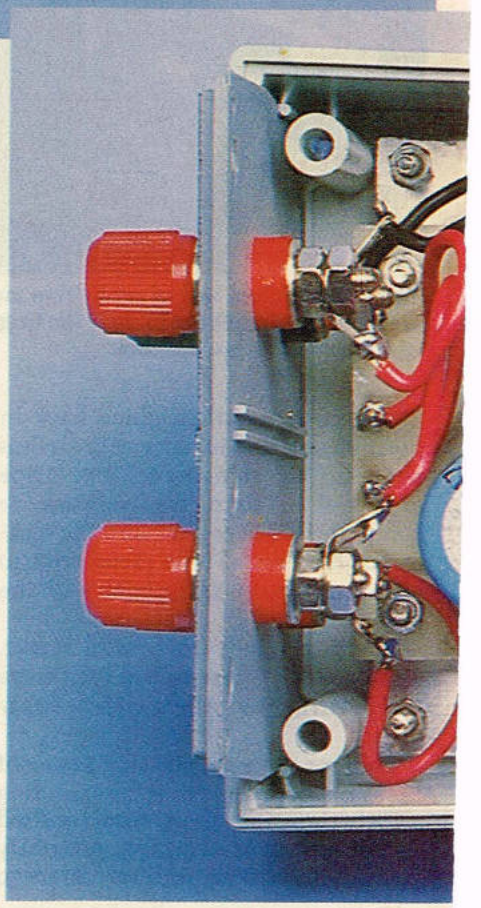
This versatile power supply has been specifically designed to power our range of stepper motor controller cards. It is also handy when a fixed +5V, +12V or +18V supply is required.

Design by RICK WALTERS

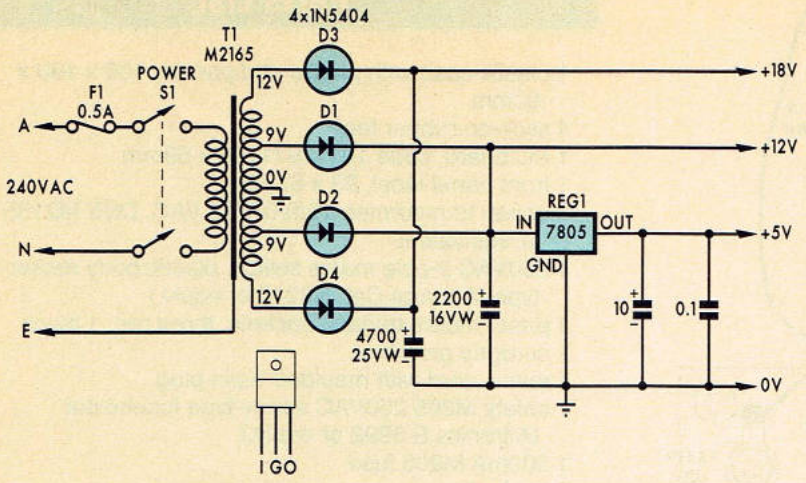
This power supply is capable of driving several stepper motor driver cards, depending on the current consumption of the motors. It can supply around 2-2.5A with moderate amounts of ripple and both 12V and 18V DC rails are available, allowing a wide range of stepper motors to be driven. In addition, a regulated +5V supply for the logic circuitry on each card is also provided and this can readily power eight or more cards.

Many of the currently available stepper motors have centre-tapped windings and are designed for operation from 5V. All the driver cards described in recent issues of SILICON CHIP utilise the full winding and don't use the centre tap. For these motors the 12V supply is ideal.

As you try to increase the stepping



RIGHT: the transformer and PC board are mounted on an earthed metal baseplate which is secured to the bottom of the case. Note that all exposed terminals on the fuse and mains switch should be sleeved with heatshrink tubing.



STEPPER POWER SUPPLY

Fig.1: the mains transformer (T1) is wired with the secondaries in series and the 9V windings are full-wave rectified using diodes D1 & D2 to give the +12V (nominal) rail. Similarly, the 12V windings are full-wave rectified using D3 & D4 to give the +18V (nominal) rail. REG1 provides the +5V rail.

speed of a motor, a point is reached where it stalls. The inductance of the windings prevents the current rising rapidly enough to move the armature before the next step arrives.

To help overcome this, motors are often run from a higher voltage than that specified, with a series resistor in each winding to keep the current within the motor's rating. The 18V supply rail can be used for this purpose.

Circuit description

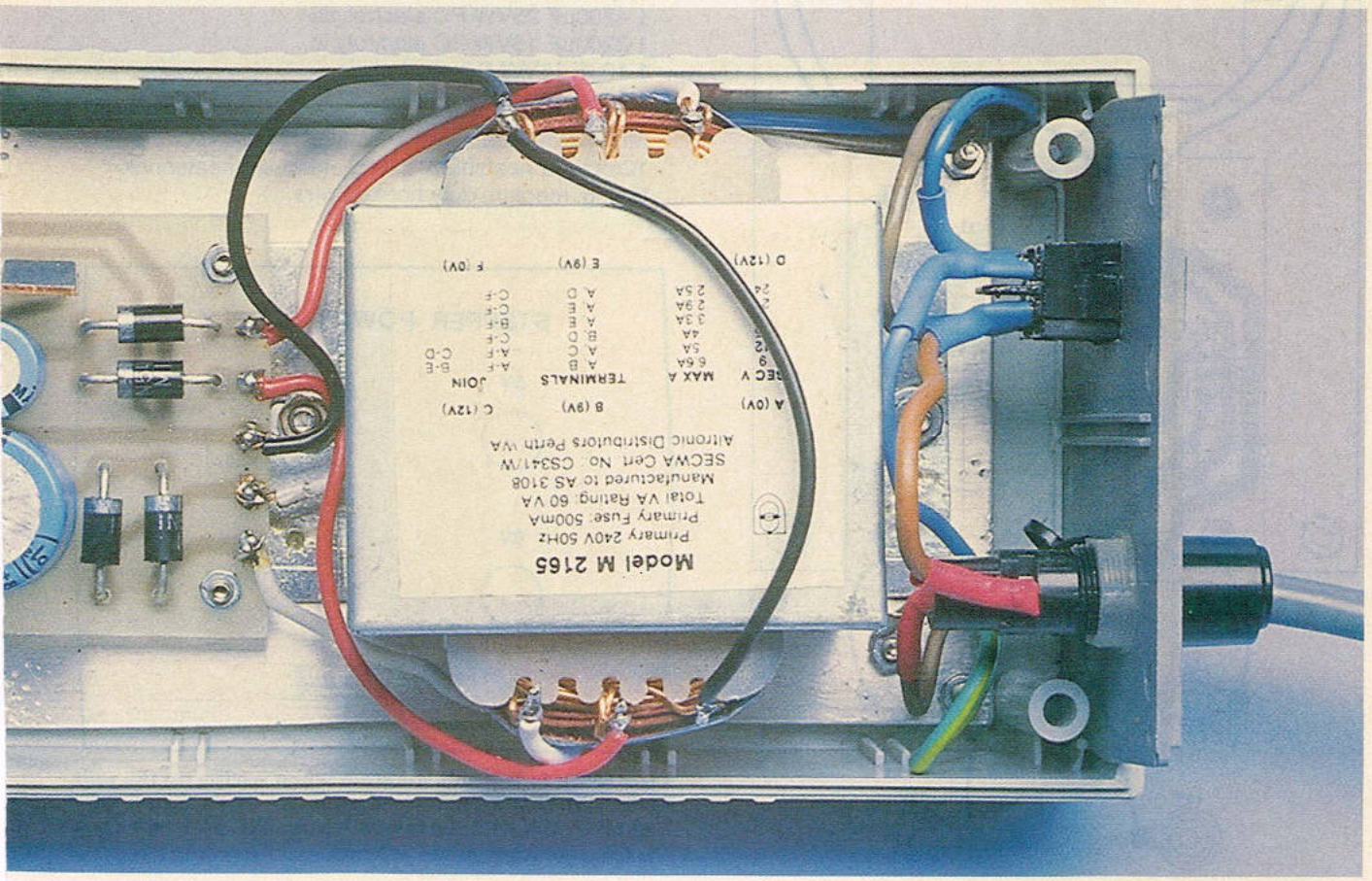
As you can see from the circuit (Fig.1), there is not much to it. The mains transformer (T1) is wired with the secondaries in series and the 9V windings are full-wave rectified using diodes D1 & D2 to give the +12V (nominal) rail. Similarly, the 12V windings are full-wave rectified using D3 & D4 to give the +18V (nominal) rail. These two rails are filtered using separate electrolytic capacitors – 2200µF for the +12V rail and 4700µF for the +18V rail.

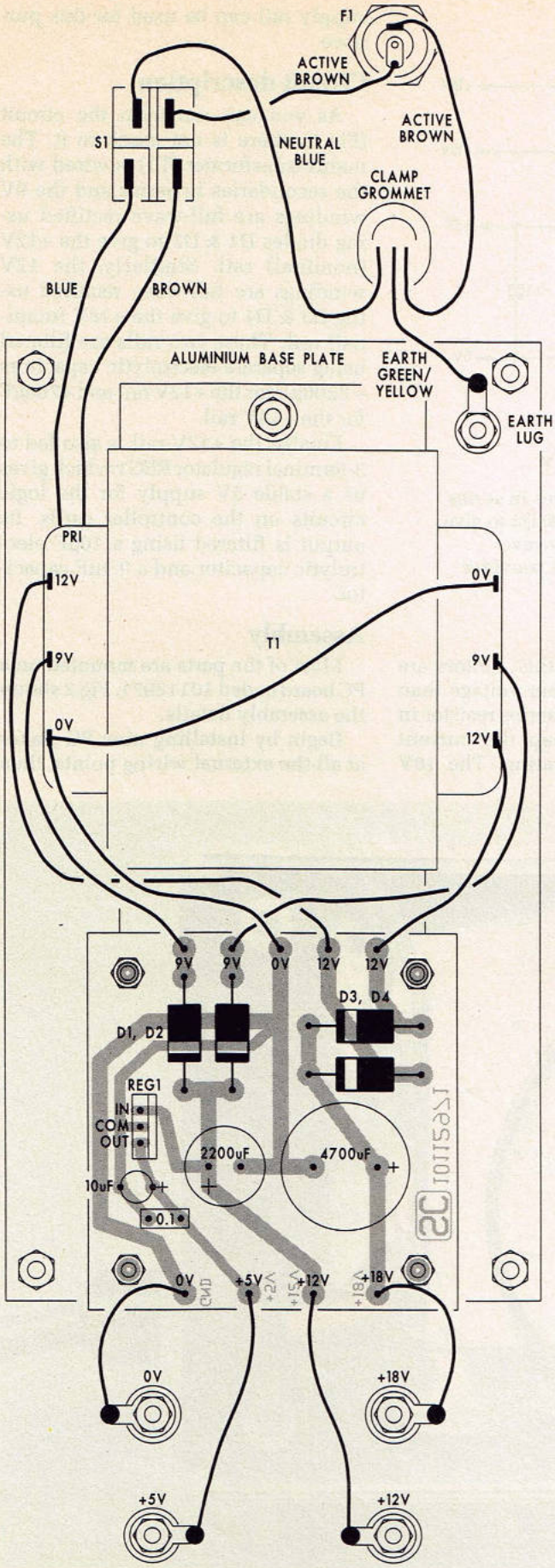
Finally, the +12V rail is also fed to 3-terminal regulator REG1 which gives us a stable 5V supply for the logic circuits on the controller cards. Its output is filtered using a 10µF electrolytic capacitor and a 0.1µF capacitor.

Assembly

Most of the parts are mounted on a PC board coded 10112971. Fig.2 shows the assembly details.

Begin by installing nine PC stakes at all the external wiring points, then





Parts List

1 plastic case with plastic end panels, 100 x 190 x 80mm
4 stick-on rubber feet
1 PC board, code 10112971, 60 x 59mm
1 front panel label, 83 x 67mm
1 power transformer, 12/9/0/9/12 VAC, DSE M2165 or equivalent
1 250VAC 2-pole mains switch, plastic body rocker type (Altonics Cat. S3212 or equiv.)
4 panel-mount banana sockets, three red, 1 black
1 cordgrip grommet
1 mains cord with moulded 3-pin plug
1 safety M205 250VAC screw-type fuseholder (Altronics S 5992 or equiv.)
1 500mA M205 fuse
1 solder lug
9 PC stakes
4 5mm-long untapped standoffs
1 3mm x 10mm long machine screw and nut
4 3mm x 15mm-long machine screws plus nuts
5 3mm star washers
4 3mm flat washers
2 4mm x 12mm-long machine screws plus nuts
2 4mm star washers
2 4mm flat washers

Semiconductors

4 1N5404 power diodes (D1-D4)
1 7805 3-terminal voltage regulator (REG1)

Capacitors

1 4700µF 25VW PC electrolytic
1 2200µF 16VW PC electrolytic
1 10µF 16VW PC electrolytic
1 0.1µF MKT polyester

Miscellaneous

12mm-dia heatshrink tubing, 4mm-dia heatshrink tubing, medium duty hookup wire

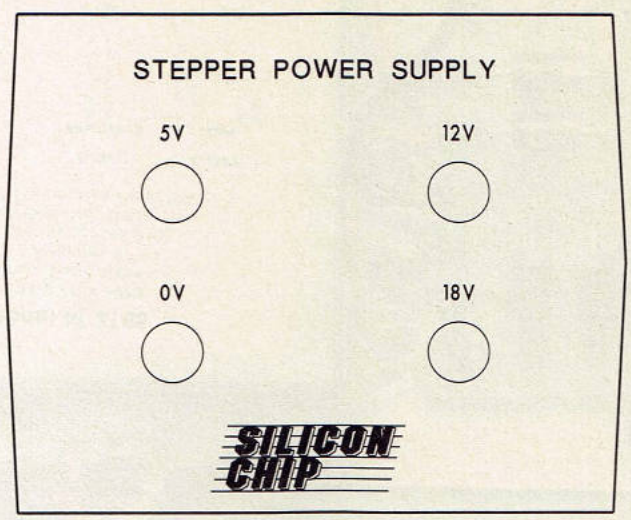


Fig.2 (left): follow this diagram when wiring up the unit. Make sure that all polarised parts are correctly oriented and take care with the mains wiring. Fig.3 (above) shows the full-size front-panel artwork.

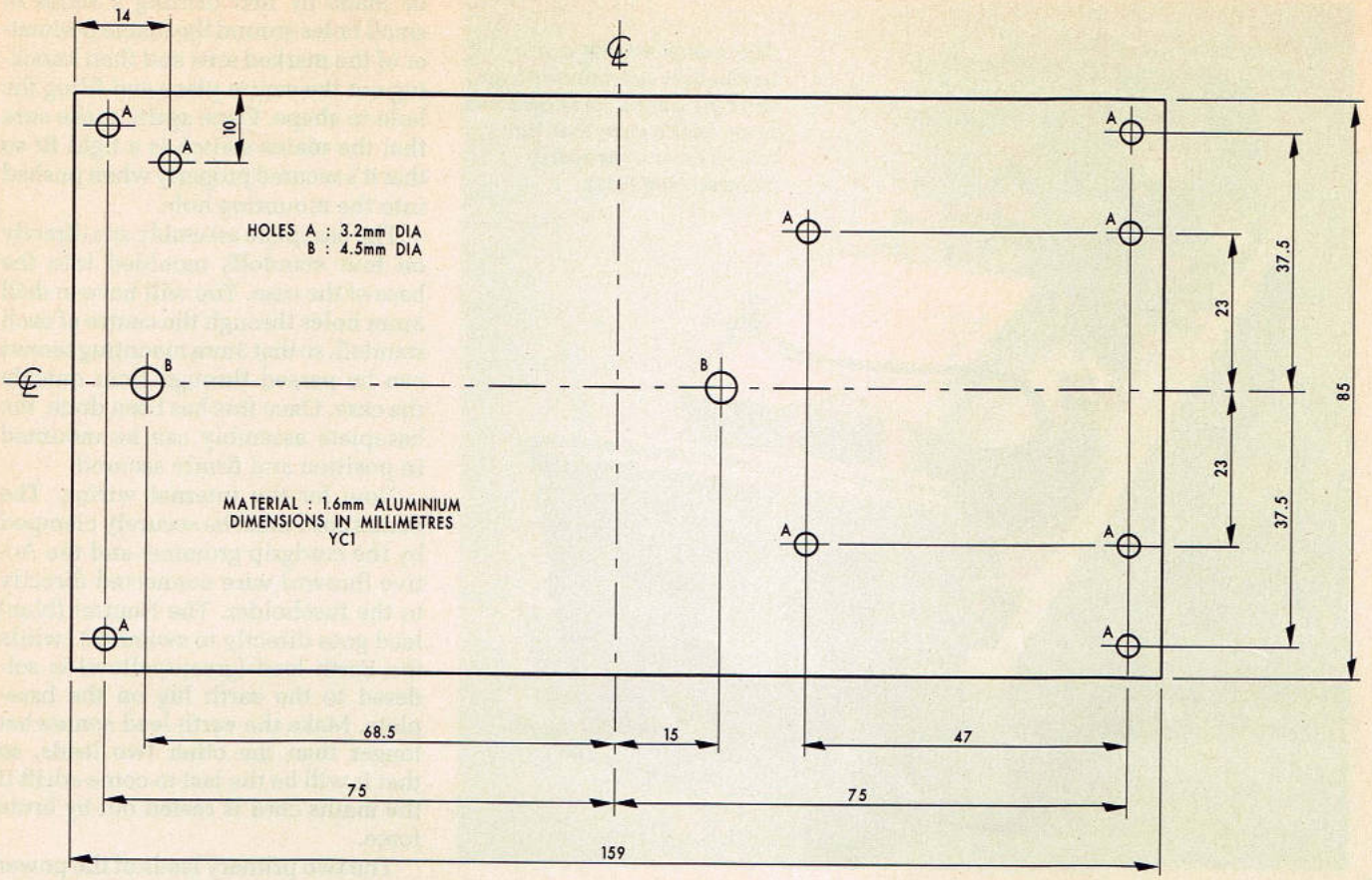


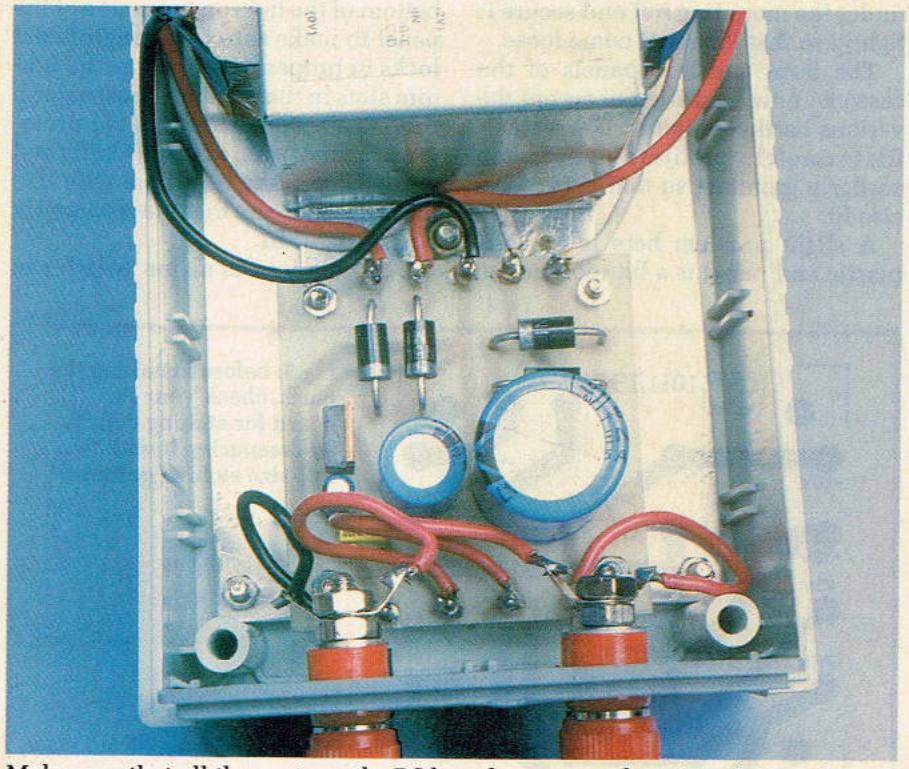
Fig.4: this diagram shows the dimensions and drilling details for the aluminium baseplate.

install diodes D1-D4, followed by the 3-terminal regulator (REG1) and the two small capacitors next to it. The large electrolytic capacitors (4700µF) can be inserted and soldered next. Be careful to observe the correct polarity here as they are likely to fail if they are put in backwards.

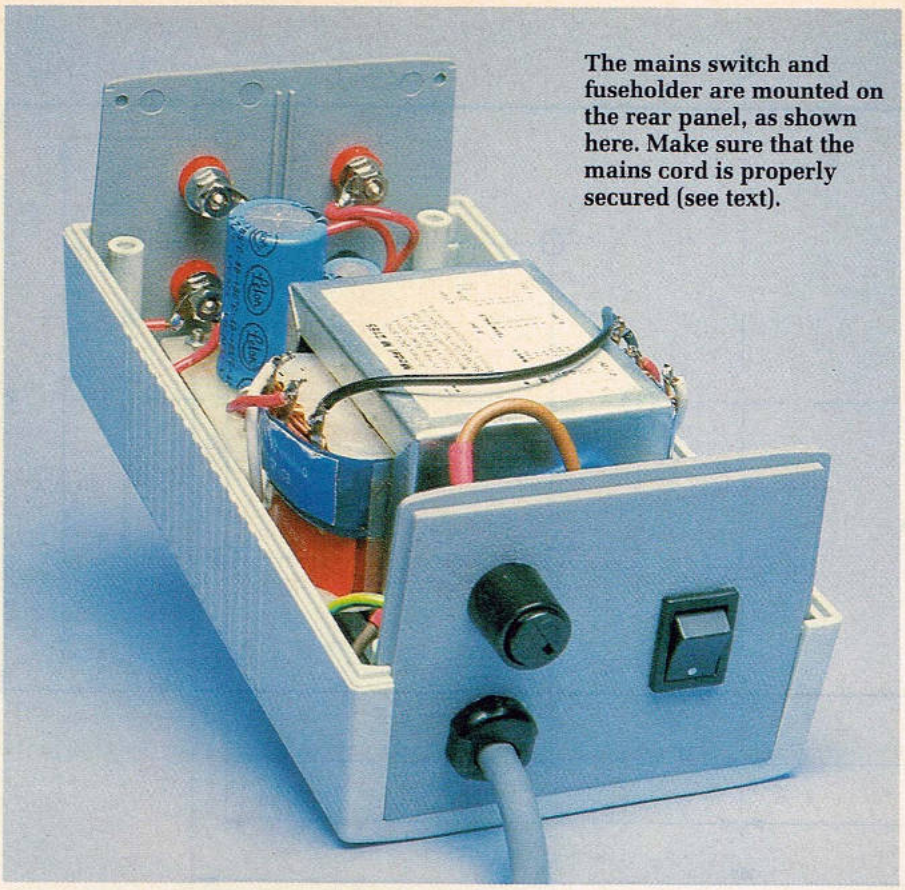
The completed PC board is housed in standard plastic case, along with the power transformer. The front panel carries four banana sockets (0V, +5V, +12V and +18V), whole the rear panel carries the cordgrip grommet, fuse and mains switch.

Both the transformer and the PC board are mounted on an aluminium baseplate (see Fig.2), which is earthed to ensure electrical safety. Drill out all the mounting holes in the baseplate, then mount the transformer and PC board in position. The transformer is secured using 4mm screws, nuts and lockwashers, while the PC board is mounted on 5mm-long standoffs and is secured using 3mm screws plus nuts and washers.

In addition, an earth solder lug should be secured to the baseplate



Make sure that all the parts on the PC board are correctly oriented. Note that PC stakes are used to terminate the external wiring connections that run from the transformer and the front panel banana socket terminals.



The mains switch and fuseholder are mounted on the rear panel, as shown here. Make sure that the mains cord is properly secured (see text).

adjacent to one of the corner mounting holes. Be sure to use a lockwasher under the mounting nut and secure it tightly so that it cannot come loose.

The front and rear panels of the case can now be drilled to accept the various hardware items. Use a small file to carefully profile the hole for the cordgrip grommet so that it is a precise fit.

A slight problem here is that the plastic end panel is a bit too thick to suit the grommet. This means that you will need to chamfer the top and bottom of the hole on the inside of the panel to make sure that the grommet locks in properly (ie, the top and bottom slots in the grommet must engage the panel). We chamfered the prototype's panel using a Stanley knife and a small file. Take your time with this job and make sure that the grommet is a neat (tight) fit.

The hole for the mains switch can be made by first drilling a series of small holes around the inside perimeter of the marked area and then knocking out the centre piece and filing the hole to shape. Once again, make sure that the mains switch is a tight fit so that it's secured properly when pushed into the mounting hole.

The baseplate assembly sits directly on four standoffs moulded into the base of the case. You will have to drill 3mm holes through the centre of each standoff, so that 3mm mounting screws can be passed through from outside the case. Once this has been done, the baseplate assembly can be mounted in position and firmly secured.

Now for the internal wiring. The mains cord must be securely clamped by the cordgrip grommet and the Active (brown) wire connected directly to the fuseholder. The Neutral (blue) lead goes directly to switch S1, while the Earth lead (green/yellow) is soldered to the earth lug on the baseplate. Make the earth lead somewhat longer than the other two leads, so that it will be the last to come adrift if the mains cord is reefed out by brute force.

The two primary leads of the power transformer go to the bottom of S1, while the remaining terminal on S1 is connected back to the second terminal on the fuseholder. Be sure to sleeve all terminals on the mains switch and fuseholder with heatshrink tubing. This is done by pushing a short length of heatshrink tubing over each lead before it is soldered. After soldering, the heatshrink is then pushed over the exposed terminal and shrunk down using a hot-air gun.

Once the mains wiring has been completed, the rear panel can be slipped into position. After that, it's simply a matter of completing the wiring to the front panel and between the PC board and the secondary terminal of the transformer. Use medium-duty hookup wire for this job.

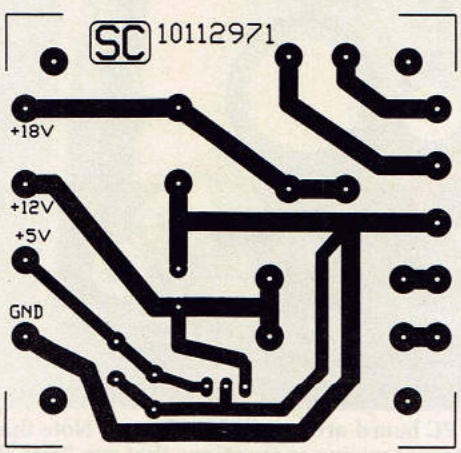


Fig.5: before installing the parts, check your PC board for etching defects by comparing it with this full-size etching pattern.

Testing

Before applying power, check your wiring carefully and use a multimeter to confirm a good connection between the transformer metalwork and the earth terminal of the mains plug. This done, attach the lid, apply power and measure the voltages on the front panel sockets. You should get readings of around 18V, 12V and 5V with respect to the 0V terminal. **SC**

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097.

Fast recovery diodes available

SILICON CHIP has limited supplies of a fast recovery diode available for free. Suitable for use in the Motor Speed Controller published in June 1997, these BYX71-350 diodes have a voltage rating of 350V, a forward current rating of 7A, a peak current rating of 60A and a recovery time of 450ns. If you want one, send us a stamped self-addressed envelope with BYX71 written on the back (Data Philips S2 05-80).

Mosfet for burnt toast cutout

I recently went back through older copies of SILICON CHIP looking for a particular project and another article caught my eye. In the February 1996 issue there was a "burnt toast cutout" for a smoke alarm. I know three people who often complain of having to fan their alarms with a newspaper to drive the smoke away and this takes a fair number of seconds to silence them, so pushing a button sounds good.

My problem is the specified BS170 Mosfet. I can't find it in any of my catalogs. I have Jaycar, DSE, Altronics, etc back to 1994 and the only Mosfets listed are dual gates and relatively expensive. BS170 is not listed or any BS types (sounds like a Philips type number?). Are there any substitutes or do you know who stocks it?

Can you give me any ideas on the National LM382 dual preamplifier IC? I have an old circuit board built up for a magnetic pickup from ETI but haven't been able to determine the supply voltage. It was in a set running on 23V DC and I feel this is too high. I have run it on a variable supply down to 9V with little obvious difference in sound. I have a regulated 15V supply; would this be OK or should I drop it to say 12V?

I cannot find any info on this IC and I noted in one of your preamplifier articles you said National Semiconductor were withdrawing the LM381/2 series of ICs. I like this IC because it uses a single supply voltage as against your preamplifier using a split supply. (P. G., Orient Point, NSW).

• BS170 Mosfets are available from Farnell Electronic Components, Sydney (phone 02 9644 7722); alternatively, Dick Smith Electronics have a suitable substitute, a VN10KM.

As far as the LM382 is concerned, it was rated for a maximum single supply of 40V. For best input overload capability it is wise to operate the chip with as high a supply voltage as possible. We would recommend running it with a supply of at least 30V. At 9V it is highly likely that a typical magnetic cartridge would severely overload it even on soft passages of music.

Much better results can be obtained from our preamplifier designs featuring the National Semiconductor LM-833.

Using the full wave speed controller

Your latest full-range speed controller published in the November 1997 issue looks impressive and I am sure it will be just the ticket for my range of tools which includes a Ryobi circular saw just like the one on the magazine cover. However, I also have an electric drill with integral speed control and I wonder if the new speed controller it will let me run this drill at a lower speed; I want to operate it as a screwdriver. (B. S., Bayswater, Vic).

• Funny that you should ask that question because that is one point that we just did not think of. In fact, we would strongly recommend that you do not use the full range speed controller with any power tool which already has an integral speed control. The chances are that the two circuits would almost certainly interfere with each other and damage may result.

Monitoring traffic noise

I want to be able to monitor traffic noise outside our house. Can I use a microphone and connect this to an A/D converter external to or part of a microcontroller board (eg, Little Giant from Z-World), so I can write software to track peaks in sound level?

Professional sound measurement devices are quite expensive but I may be able to graph noise level patterns more effectively with my own software. It could be the accuracy of the microphone is the critical aspect but a simple microphone could be a good way to start. Perhaps SILICON CHIP has had such a project? (N. P., Tamworth, NSW.

• We suggest you consider employing the Sound Level Meter featured in the December 1996 issue of SILICON CHIP. This has the advantage of a logarithmic DC output (10mV/dB) and also has the options of A & C weighting as well as unweighted measurements. The DC output could be easily linked to the A/D converter in your micro or direct to your PC.

Making a colour TV from odds & sods

I have an old National VCR, several spare audio amps ranging from 2W to 100W and a perfectly good RGB monitor currently doing occasional duty on an old BBC computer. I would like to connect the three together to make a colour TV for the workshop. My knowledge of electronics says that it should be possible to connect the monitor to the VCR with a circuit to split the composite video to the three colours plus sync. Is it feasible and reasonably cheap and if so, would it be possible to do a project on this in SILICON CHIP? There must be a lot of

Preventing solenoid burnout

I am using a 12V Superwinch boat winch to load beehives and find that the forward and reverse solenoids don't last. The motor is a permanent magnet two-brush design and draws up to 60 amps. I have tried two different arrangements for connecting the solenoids (diagrams supplied). The first method just burns the points black while the second burns the points and destroys the motor brushes and the motor stops dead when the power is off. The solenoids are from a golf buggy. What size capacitor would I need to protect the points? Is it possible to electronically switch this much power? (B. P., Cooke Plains, SA).

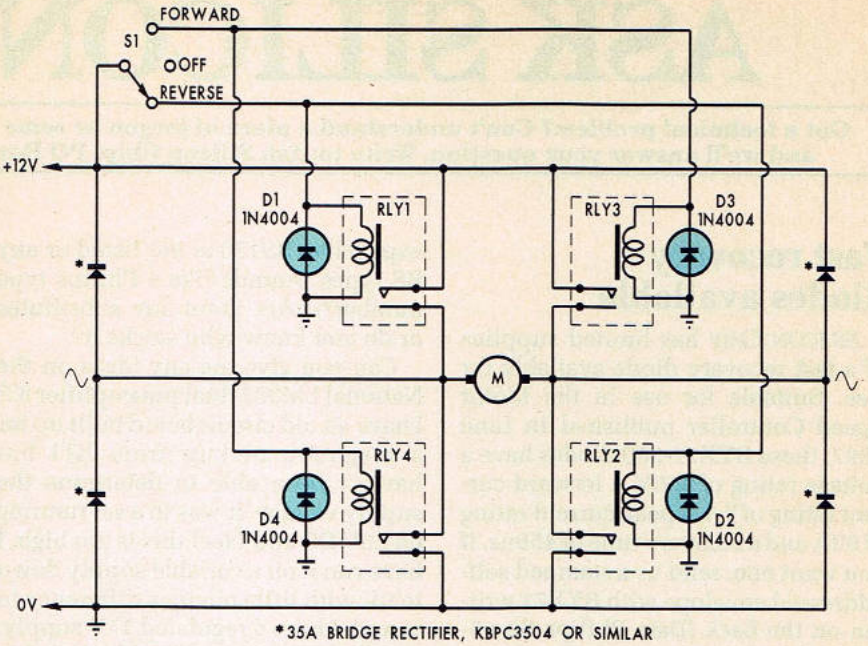
• We assume that you are using the solenoids to switch the motor between forward and reverse without stopping. This will cause severe contact burning, as you have found, for two reasons. First, at the instant of switching, the two pairs of solenoids will be connected directly across the battery supply (ie, a direct short across the battery) and hundreds of amps will flow. Second, if you switch a motor from forward to reverse without letting it come to a stop, it will generate a very high back-EMF which will cause contact arcing and again, very high surge currents.

Capacitors cannot cure this problem. You need to arrange the solenoid switching so that there is a slight delay between the motor being switched from forward to reverse and vice versa. This can be achieved by using a switch with a centre-off position. Second, you need to have diode quenching across each set of solenoid contacts and the diodes need to be able to handle high transient currents.

Our suggestion is to use the circuit in the accompanying diagram. It shows a 35A bridge rectifier connected so that each of its diodes is connected across one set of solenoid contacts. The way to do this is to connect the positive terminal of the bridge to the +12V and the negative terminal to 0V. The two AC terminals of the bridge rectifier then connect across the motor.

We have shown a centre-off switch as the forward/reverse control and have specified a 1N4004 diode across each solenoid coil. When using this setup we suggest that if you need to switch the motor directly from forward to reverse without stopping that you at least pause in the centre-off position when operating the control switch. That will reduce the switching transients and increase the brush life of the motor.

You could do the switching job electronically but it would be considerably more expensive.



CGA, VGA monitors around and also a fair number of old tape chewing VCRs which could be used as the tuner. In my case the monitor uses a 5-pin DIN plug on the computer end of the lead and a SCART plug on the monitor end.

My second question is that of VA ratings of transformers and how it relates to the watts and voltage requirements of a particular amplifier module. Years ago I built a 170W Mosfet amplifier module and bought the recommended power toroidal transformer which was a 160VA unit producing ±35V DC. Some time later I bought another module which I have not yet assembled.

Will it be possible to run the two modules from the one power supply? What would be the implications? The first module is doing duty in a small band PA system with two 8Ω speakers in parallel. I would probably run it in stereo with the extra module, with one 8Ω speaker per module.

A third related question is what will happen if I run an amplifier module like the 100W off say half of the normal voltage? Are there any problems with quiescent current settings for example? I am aware that feeding it with a high input signal would cause clipping earlier with the lower supply voltage. (B. L., Cranbourne South, Vic).

• If your RGB monitor has a SCART plug, there is a possibility that it already has a composite video input, even though it is not wired into the DIN plug. Normally, you would expect to find the composite video input on pin 20. This input may need to enabled with +12V applied to pin 8 of the same socket.

On the other hand, if your RGB monitor does not have a composite video input, you need a circuit to convert composite PAL video to RGB and

we are assuming that the monitor is compatible in terms of vertical and horizontal sweep frequencies. Unfortunately, we have not published a circuit which will allow you to do this although, as you might expect, it is to be found in every PAL TV receiver.

Most VGA monitors could not be directly adapted to PAL video since their horizontal sweep frequencies are usually much faster than 15.625kHz.

As far as the VA rating of transformers is concerned, it is usually the case to assume that wattage and VA ratings are equivalent; ie, 100VA is equivalent to 100W. If there is a substantial phase difference between the load voltage and current, the VA rating may need to be higher than the wattage.

If you are running a class B or class AB amplifier, the maximum power drawn from the supply will be approximately 60% higher than the power delivered. For example, your 170W amplifier module would pull about 270W from the DC power supply. When you allow for inefficiencies in the rectifier and filter capacitors and so on, the actual power drawn from the power transformer could be expected to be around 300W or more.

On the other hand, most audio power amplifiers are rarely driven flat out and so it is possible to get away with a smaller transformer. However, we would regard a 160VA transformer as a little small for a 170W module. With two such modules, the transformer would definitely not be up to the task and the modules would not give their best. We would suggest a minimum transformer rating of around 300VA for your two modules.

If the system is to be used for band or disco work, where it is likely to be driven much harder, then the transformer should be rated at around 500VA or more.

If you operate an amplifier module at half its design voltage you can expect to obtain less than one quarter of its rated power. For a 100W module operated at half supply, we would expect a maximum power output of about 20W. Naturally, the quiescent current would need to be adjusted to suit the new supply conditions. It is also possible that other bias conditions in the amplifier would no longer be optimum and this could lead to more distortion and less power again.

CCTV for model railways

I especially enjoy the SILICON CHIP model railroad projects which brings me to my question. Talking with fellow model railroaders, the consensus is a wish for viewing the railroad as from the engineer's view, from the locomotive via a small TV set. I remember Lionel promoted this system a few years ago with a CCD camera mounted in the locomotive but it seems to have faded into obscurity.

With the cost of CCD cameras and also the size getting smaller, would it be possible to fit such a system into a dummy HO diesel locomotive? I notice in your October 1997 issue that Oatley Electronics advertises a mini TV station. Could this be combined with the CCD camera in the dummy loco to transmit to a TV?

I would be interested in your view as to whether it would be practical or not. (W. D., Auckland, NZ).

• We are familiar with the Lionel video system you refer to but it was not a success, as we understand. It was plagued by very short battery life and was also black & white instead of colour. Even so, it was quite a technical achievement to be able to send a video signal along the rails without much interference from the locomotive motor and whatever else might produce hash.

These days you could probably adapt a B&W CCD camera module into a dummy diesel and run it from track power but if we were to design such a system it could not transmit the video signal along the track as it would be incompatible with most train controllers, especially those using PWM techniques. If the signal was to be directly radiated, it could also be subject to interference from locomotive motors, train controllers and so on.

We are publishing your letter to see how much interest there would be from other readers in a project along these lines.

Jumbo clock modifications

I am using the Compact Jumbo Clock as an event timer with displays 1, 2 and 3 only. I have omitted the circuit for display 4 so that display 3 only counts from 0-9. At switch on I would like to reset display 3 to 0 each time, as do displays 1 and 2 at switch on. I would appreciate it very much if you are able to supply any modifications to achieve this, as at present display 3 displays random numbers at switch on. (R. M., Mount Duneed, Vic).

• The modification required to automatically reset the third digit involves tying the J1 input (pin 4) of IC8 to 0V and connecting the load input (pin 4) of IC8 to pin 1 of IC4. You will need to cut some of the PC tracks to accomplish this. **SC**

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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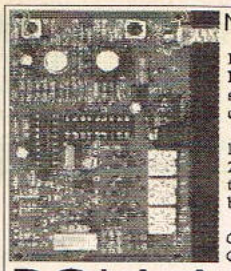

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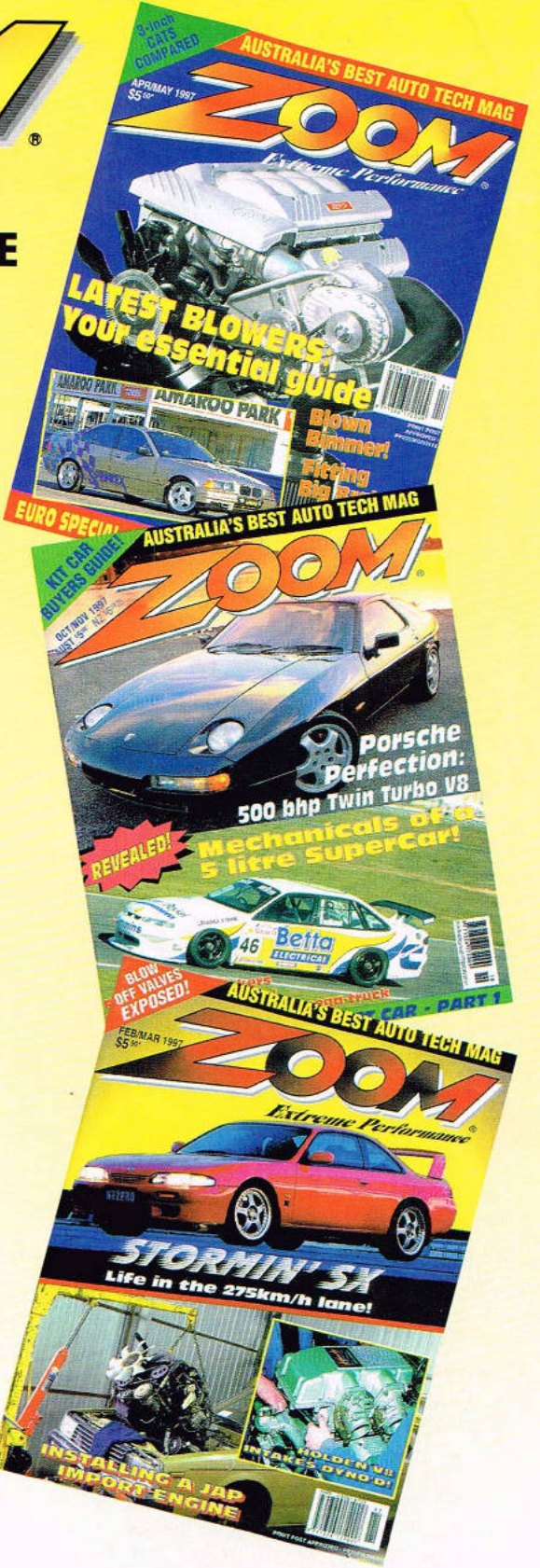

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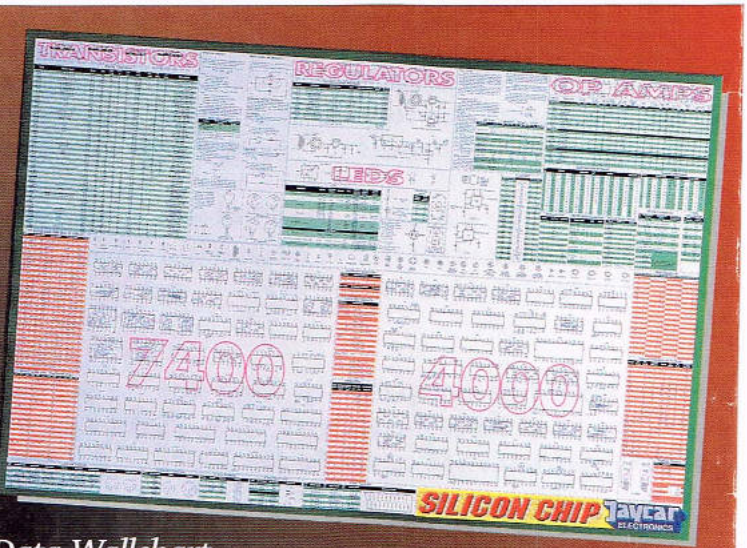

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